NOAA Technical Memorandum NMFS F/NWR - 2

This TM series is used for documentation and timely communication of preliminary results, interim reports, or special purpose information; and have not received complete formal review, editorial control, or detailed editing.

FISH TRANSPORTATION OVERSIGHT TEAM ANNUAL REPORT-FY 1981
TRANSPORT OPERATIONS ON THE SNAKE AND COLUMBIA RIVERS

LARRY R. BASHAM, MICHAEL R. DELARM, JAMES B. ATHEARN, AND STEPHEN W. PETTIT

MARCH 1982

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldridge, Secretary
National Oceanic and Atmospheric Administration
John Byrne, Administrator
National Marine Fisheries Service
William G. Gordon, Assistant Administrator for Fisheries

TABLE OF CONTENTS

TRANSPORT OPERATIONS ON THE SNAKE AND COLUMBIA RIVERS, 1981

Introduction

The collection and mass transportation of juvenile salmonids occurred this season at Lower Granite, River Mile (RM) 431.8 and Little Goose (RM 394.6) which are located on the Snake River, and McNary Dam (RM 292) on the Columbia River (Figure 1). The Snake River joins the Columbia River at RM 324.3. All smolts transported from the collector dams are released below Bonneville Dam (RM 146.1). Smolts are transported past 4 to 8 dams and from 146 to 280 miles of slack water to reduce both turbine and pool related mortalities.

This was a transitional year for transport activities on the Snake and Columbia Rivers. The transportation program changed from a research mode of operation formerly operated by the National Marine Fisheries Service (NMFS), Northwest and Alaska Fisheries Center (NWAFC), to a management operation manned by the North Pacific Walla Walla District Corps of Engineers (NPW). The NPW provided funding and manpower to operate the program while the fishery agencies provided biological oversight. NWAFC biologists, experienced in the transportation program, were contracted to provide continuity during the transition, and to train state and NPW personnel for future management of the operation.

To manage the transportation program a Fish Transportation Oversight Team (FTOT) was formed. The team provided coordination between fishery agencies and NPW. FTOT is composed of a NMFS Transportation Coordinator (Chairman), a NPW fishery biologist, and an Idaho Department of Fish and Game fishery biologist. The team is responsible for setting criteria for the program in an annual work plan. They conduct on-site project inspections prior to, during, and after the season to insure the protection of migrating juvenile salmonids. FTOT produces and the Environmental and Technical Services Division of the NMFS in Portland, Oregon, will publish an annual report which summarizes that year's transport activities. The transportation program's organization, and the responsibilities of the NPW and fishery agencies, are shown in Figure 2.

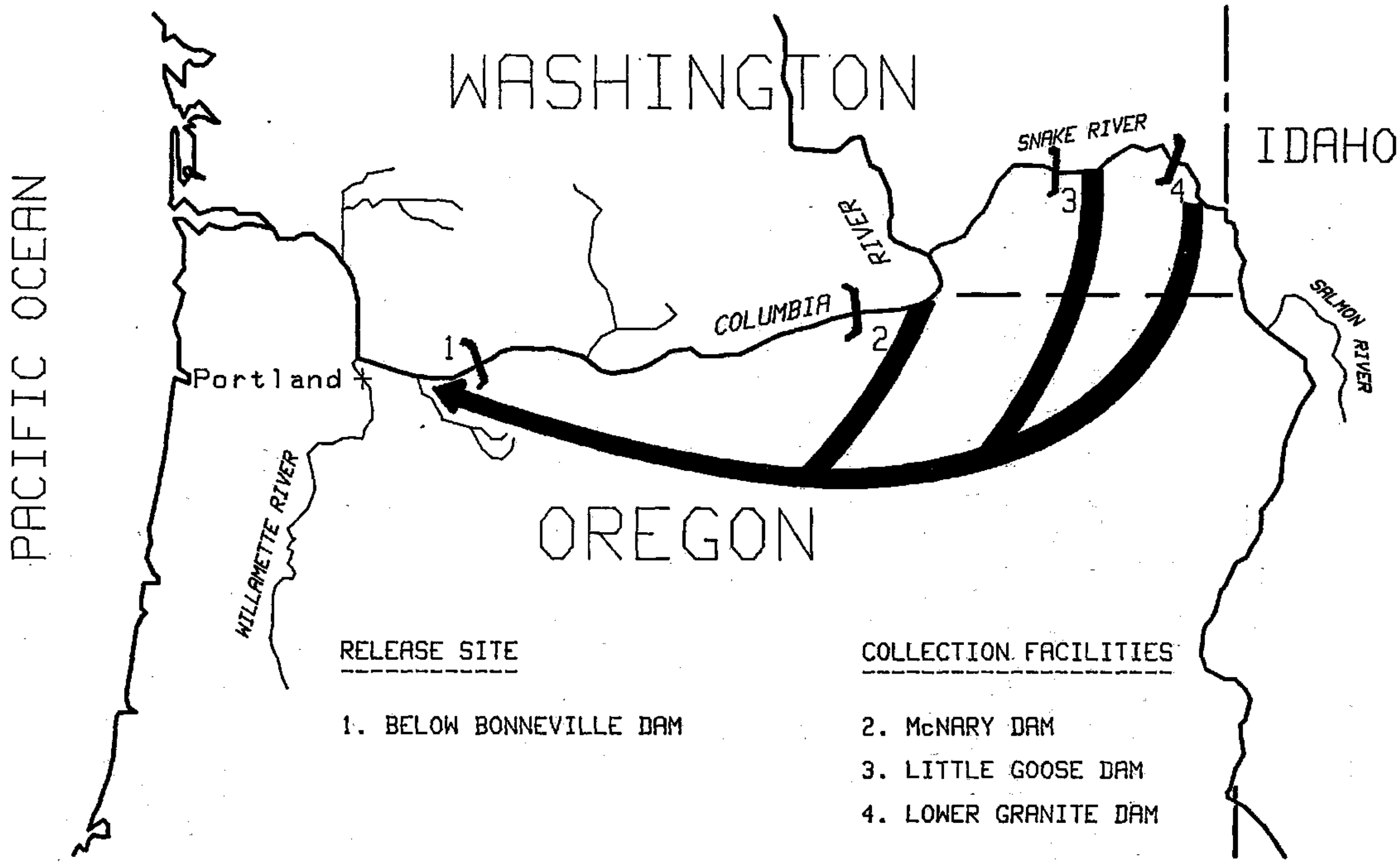
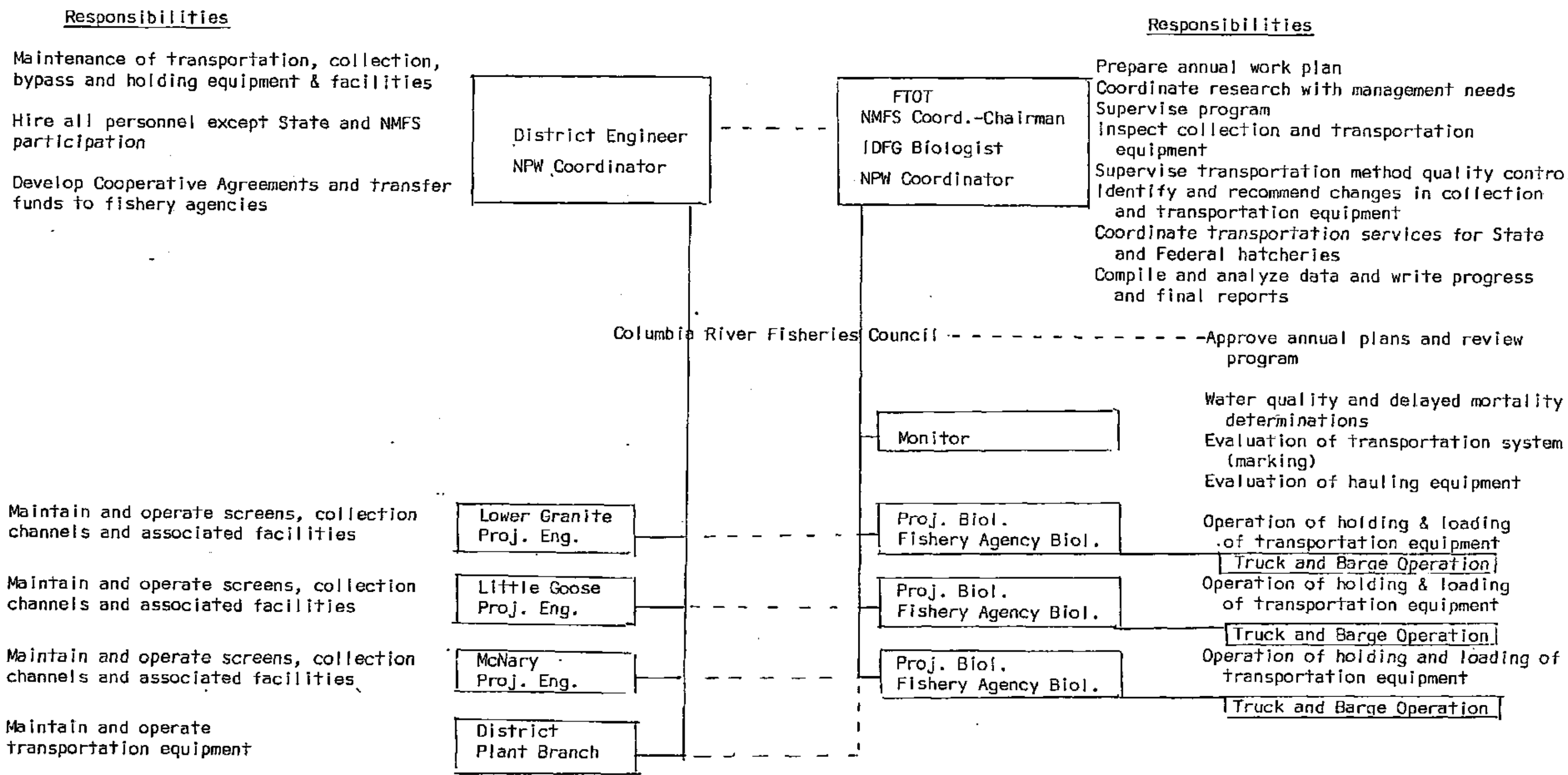


Figure 1.-- LOCATIONS OF FISH COLLECTION FACILITIES, TRANSPORTATION ROUTE, AND RELEASE SITE.

Figure 2 - Line of authority and responsibilities for trapping and transportation of juvenile salmon and steelhead trout from collection points at Lower Granite, Little Goose, and McNary lock and dam projects to release sites below Bonneville lock and dam.



The agencies involved with the program are interested in increasing survival of transported juveniles. To date, chinook smolts seem more susceptible to stress and crowding than do the steelhead smolts. Reduced densities both in holding and transporting of fish may be a key to reducing stress and improving survival of smolts. For this reason, maximum holding rates were 0.5 lb of fish per gallon of water for all species at McNary and for chinook on the Snake River. Steelhead collected at Snake River projects were held at a maximum 1 lb. of fish per gallon of water. Truck loading densities were 0.5 lb fish per gallon at all projects. Barge loading criterion was 5 lbs. of fish per gallon per minute (gpm) water flow. The above densities were one half the density rates of previous years except for Snake River steelhead. Steelhead were kept at the lower densities whenever possible.

A goal at transport dams was to limit the number of fish being handled throughout the collection period. Approximately 5 to 10 percent of the juveniles collected were handled. Fish handled for marking experiments, species composition checks, or weight samples were obtained from a random sample of the total population arriving at the project facility in a 24 hour time period.

At collector dams, spill was not requested for juvenile fish passage. The transportation program's objective was to collect maximum numbers of juvenile salmonids and safely transport them below Bonneville Dam for release. By increasing fish survival to below Bonneville Dam through transportation, it is expected that increased adult fish numbers will return in the future.

This report summarizes and describes the 1981 transport operations including numbers of salmonids transported by species, overall fish condition, environmental effects, and facility and equipment operations.

RIVER AND OUTMIGRATION CONDITIONS

Flows, as recommended under Section 4(h) of the Regional Power Act, are necessary for emigrating salmonids. Raymond (1979) and Sims [1/] have addressed migration rates and timing of fish through the various pools under different flow regimes. A definite positive correlation was shown to exist between increased flows and reduced migration time through a reservoir. Survival, as measured from Ice Harbor Dam to The Dalles Dam, was also increased. The 1977 drought was a good example of the detrimental effect extreme low flows had on juvenile survival.

Migrating juvenile spring chinook salmon traditionally peak in late April or early May. Steelhead migrants from the Snake River peak twice; the first peak generally follows the chinook peak by a few days, and the second peak occurs from mid to late May. Juvenile migration peaks historically have been associated with spring freshets or peak flow periods. A positive correlation exists between flow and fish collection. Figures 3 to 9 are plotted for years 1978-1981 at Lower Granite and 1979-1981 at McNary to show this relationship.

Snake River

The weather and runoff in the Snake River system presented some unique conditions in 1981. The winter and early spring was one of the warmest and driest on record, resulting in drought conditions being forecast for the Snake River Basin. The March 1 forecast made by the Northwest River Forecast Center (NRFC) predicted only 64% of normal runoff at Lower Granite. The poor snow pack provided runoff conditions of less than 35,000 cubic feet per second (kcfs) prior to mid April.

1/ Sims, C.S., Ossiander, F.J. June 1981. Migrations of juvenile chinook salmon and steelhead trout in the Snake River from 1973 to 1979. Final report to U.S. Army Corps of Engineers. Contract No. DACW68-78-C-0038. NOAA, NMFS, NWAFC, Seattle, WA. 31 p.

Figure 3.--Flows vs. juvenile fish numbers at Lower Granite Dam, 1978.

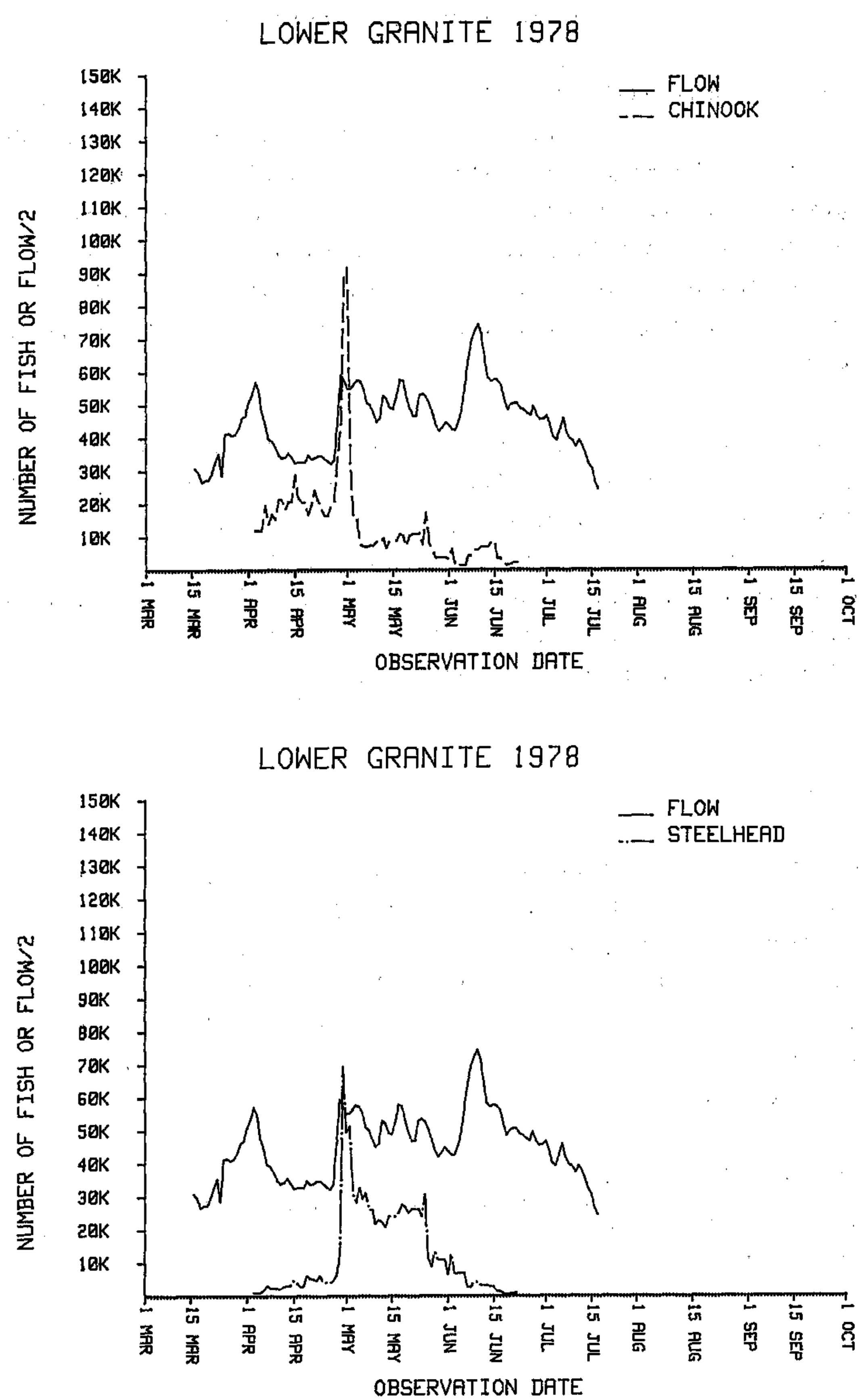
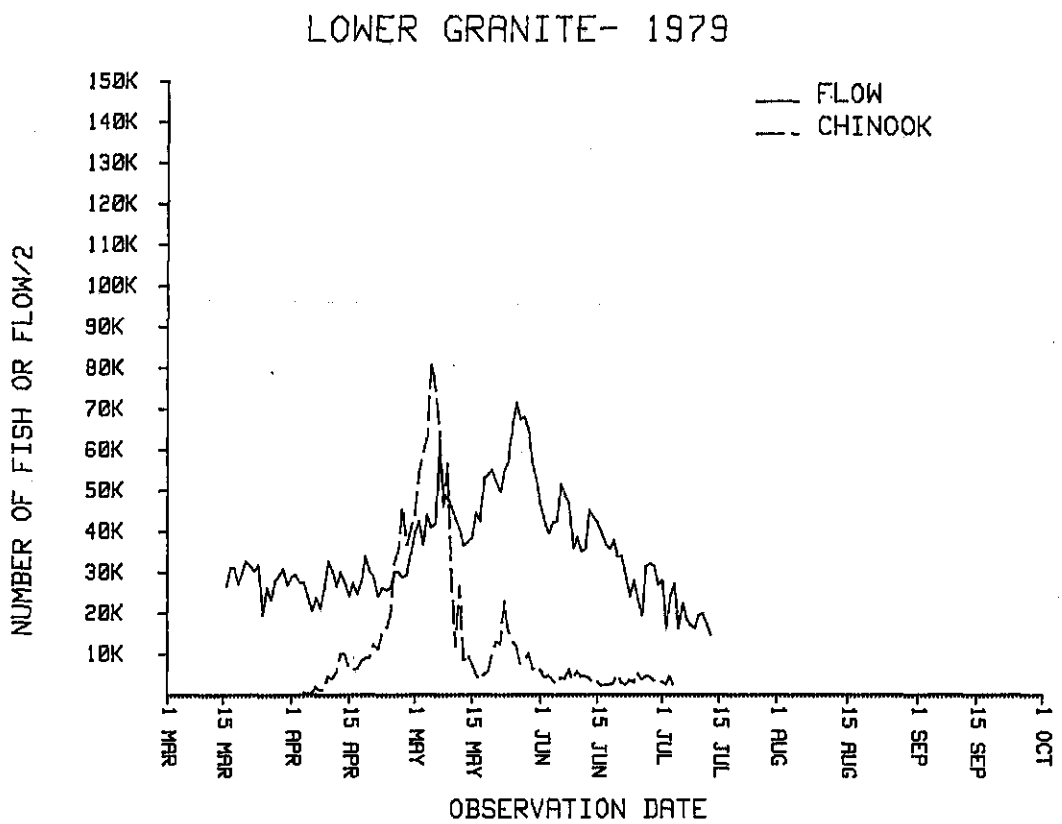


Figure 4.--Flows vs. juvenile fish numbers at Lower Granite Dam, 1979.



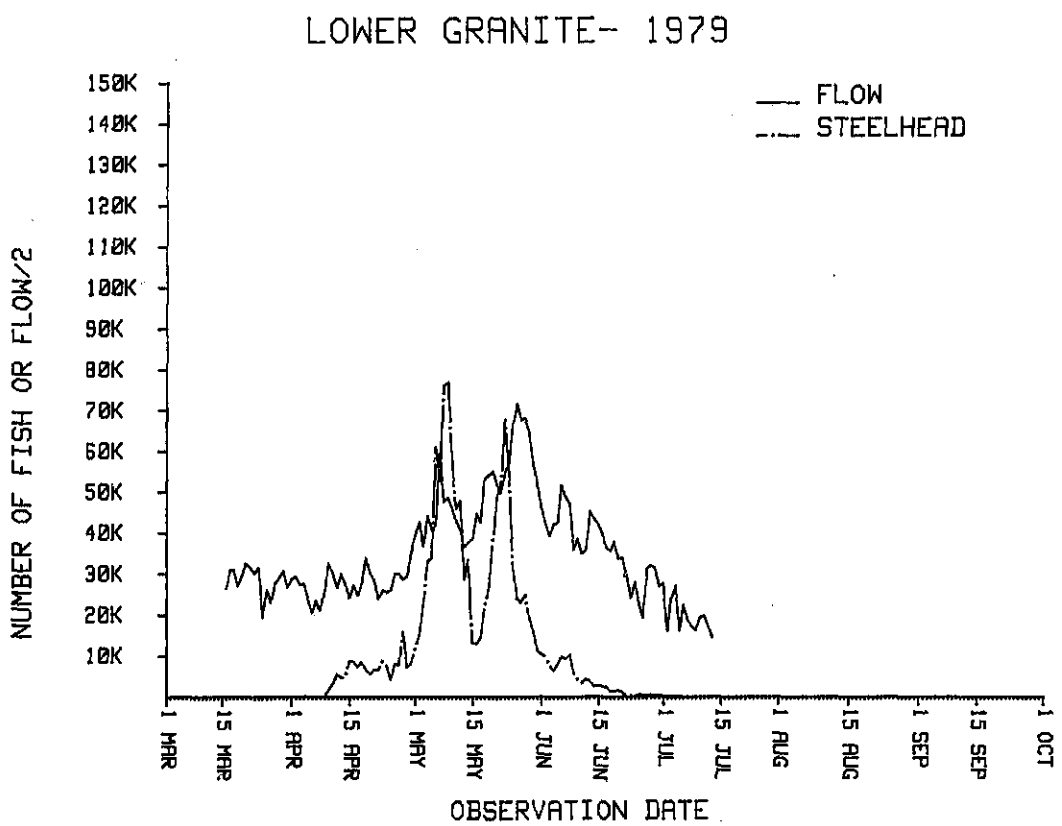
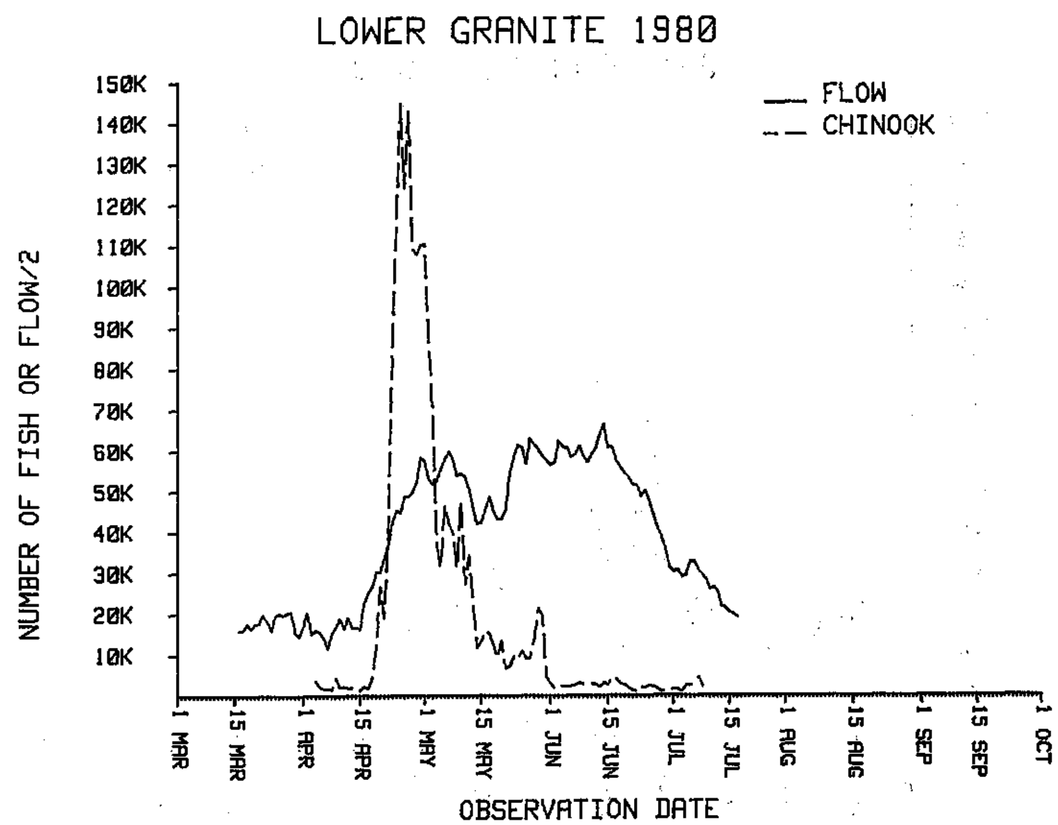


Figure 5.--Flows vs. juvenile fish numbers at Lower Granite Dam, 1980.



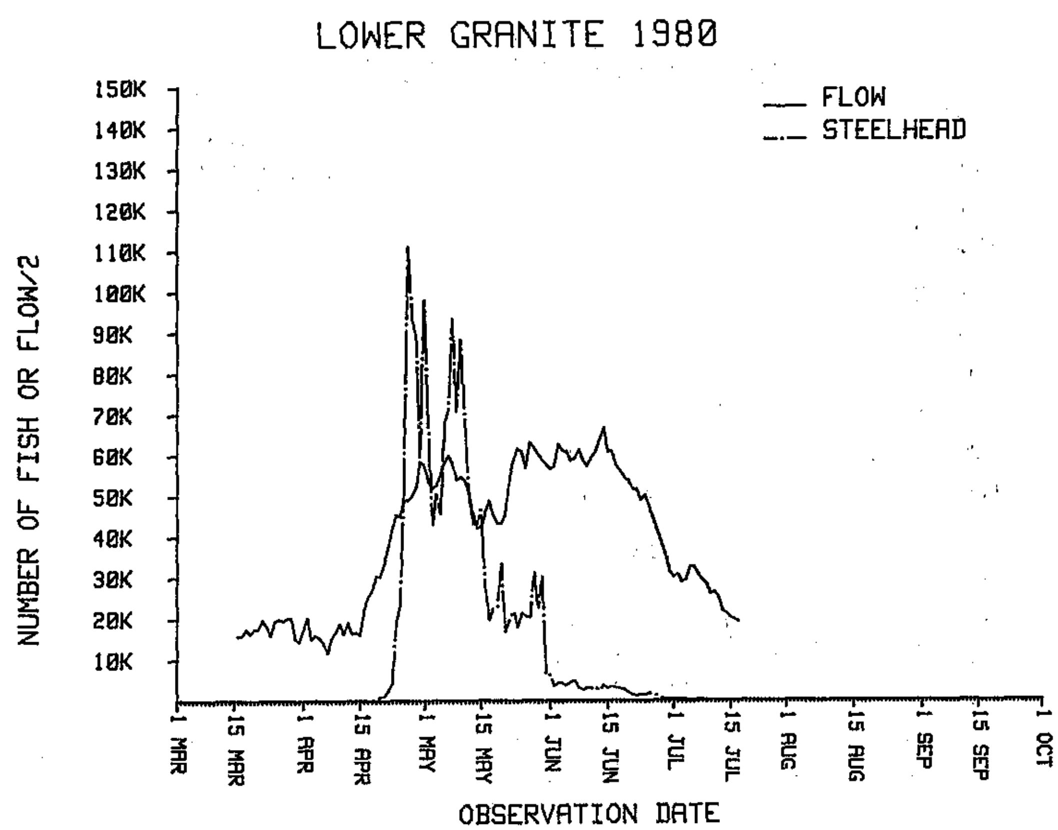


Figure 6.--Flows vs. juvenile fish numbers at Lower Granite Dam, 1981.

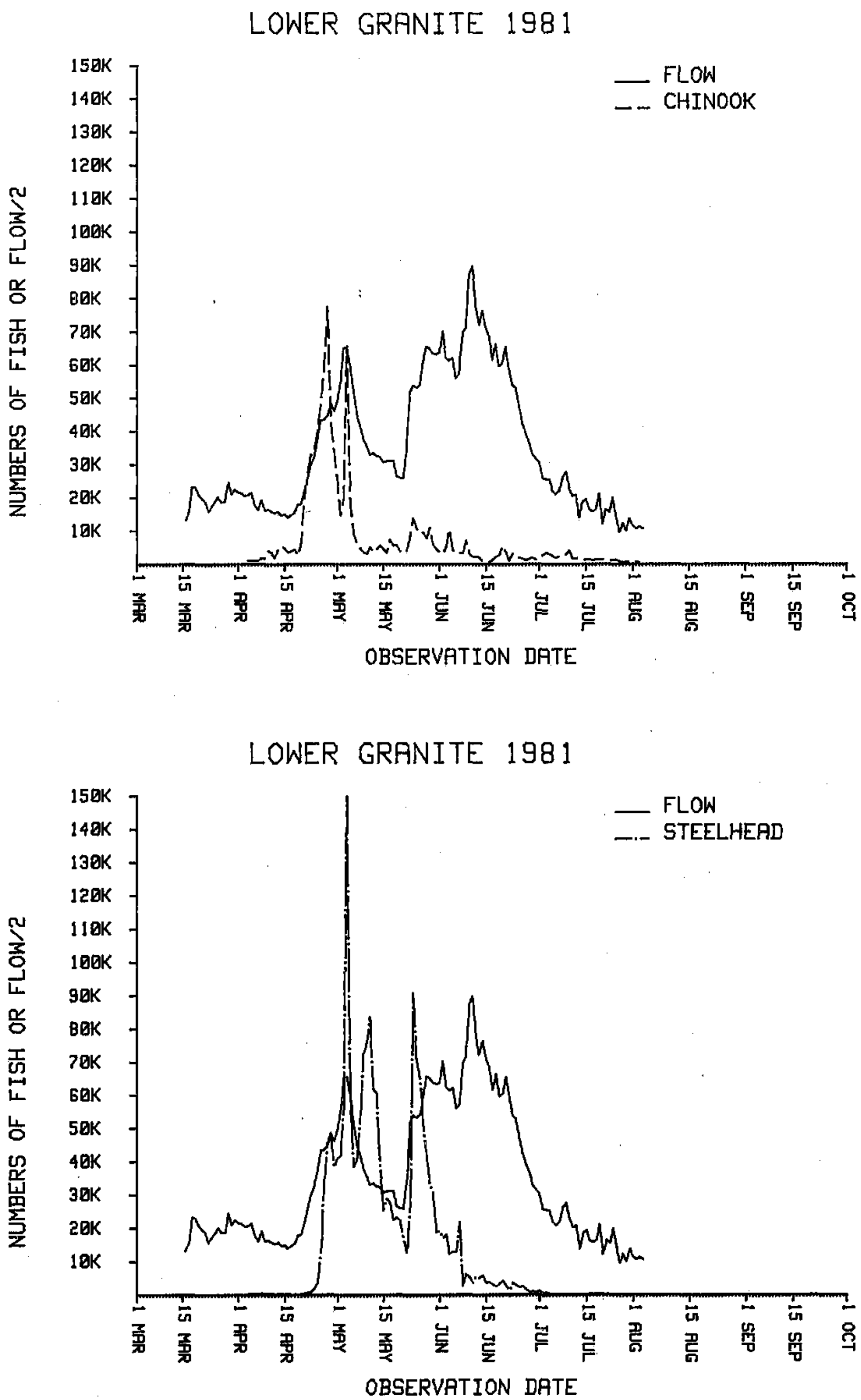
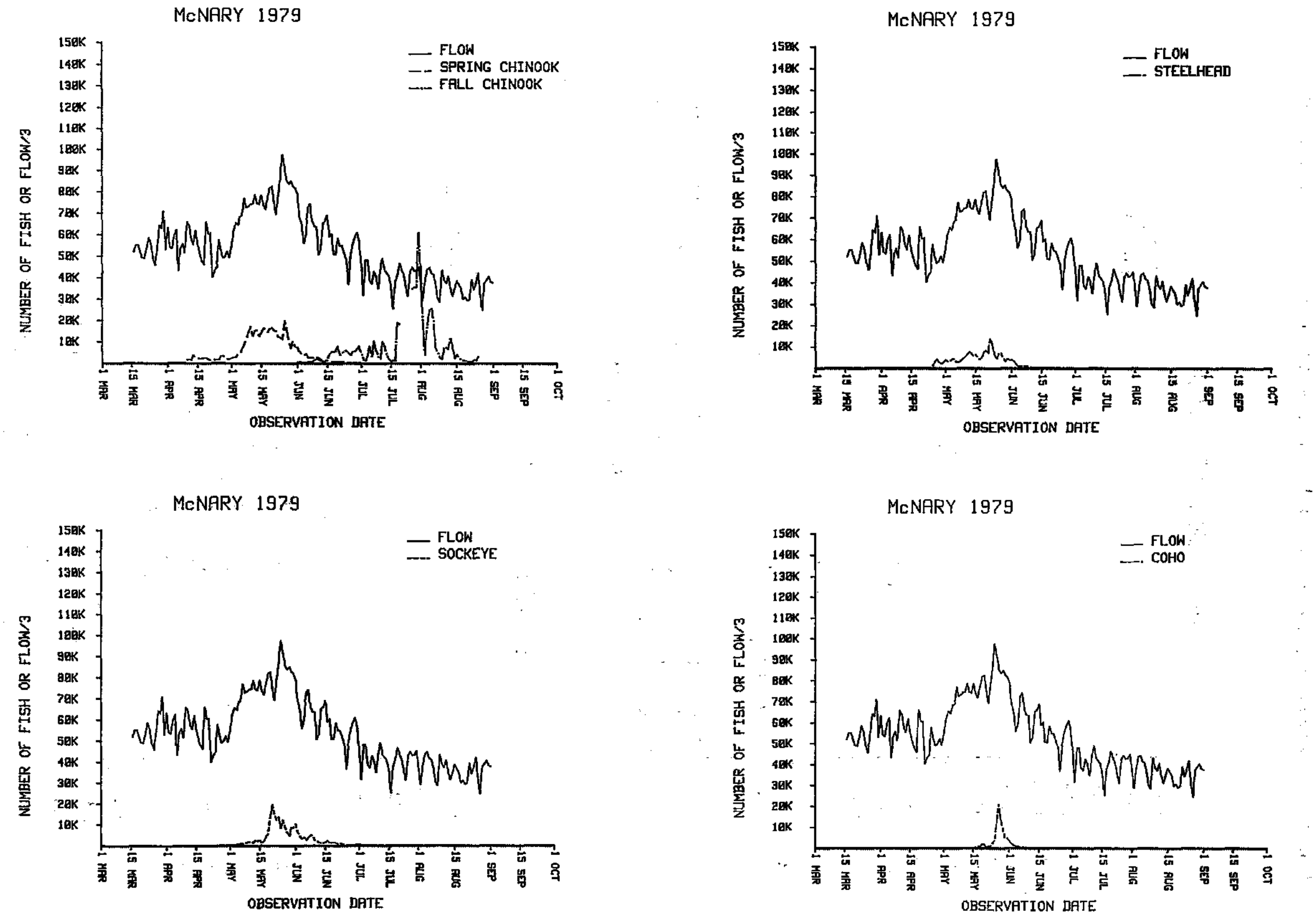


Figure 7.--Columbia River flows versus daily counts of juvenile spring chinook, fall chinook, steelhead, sockeye, and coho during 1979 at McNary Dam.



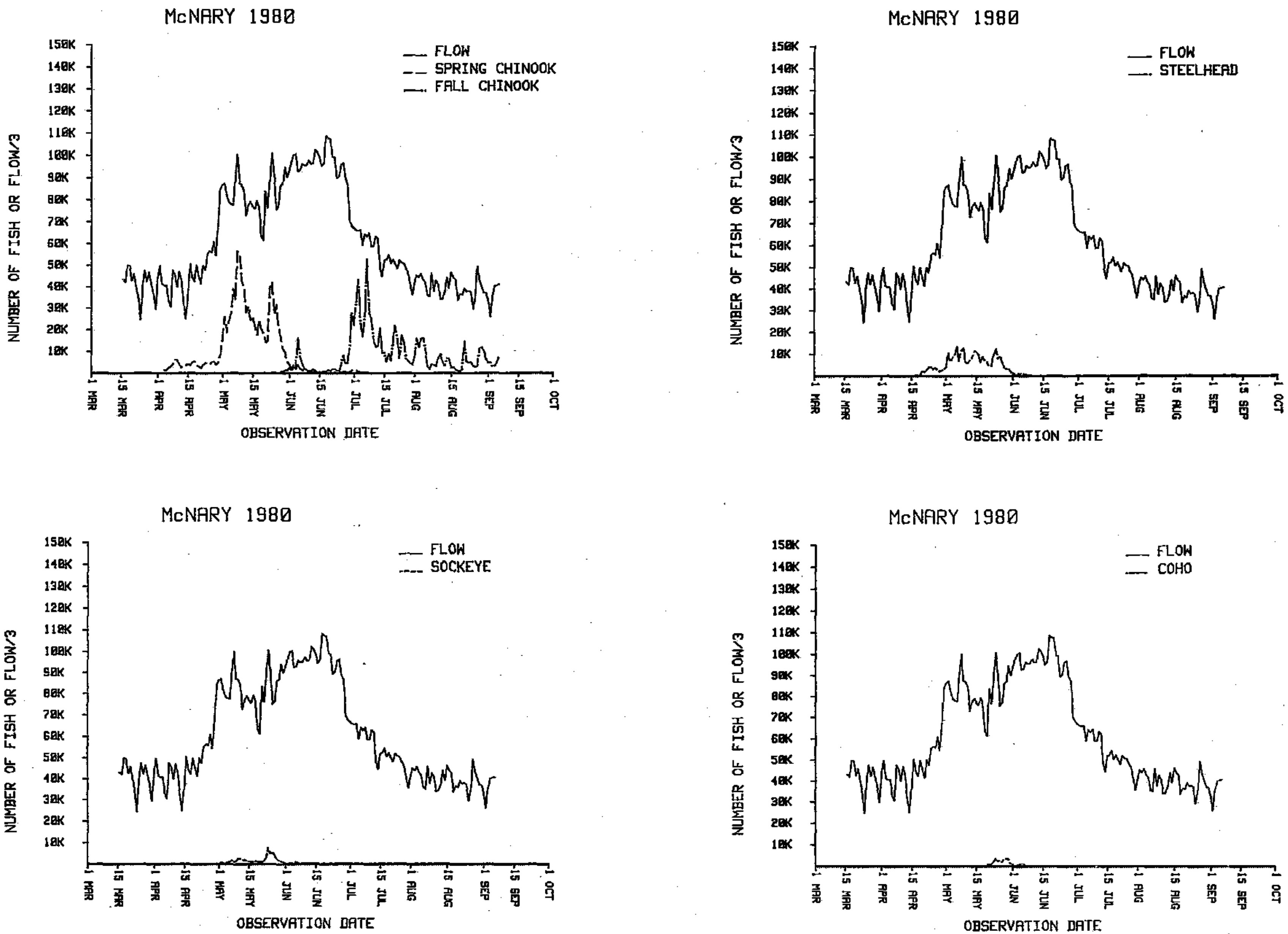
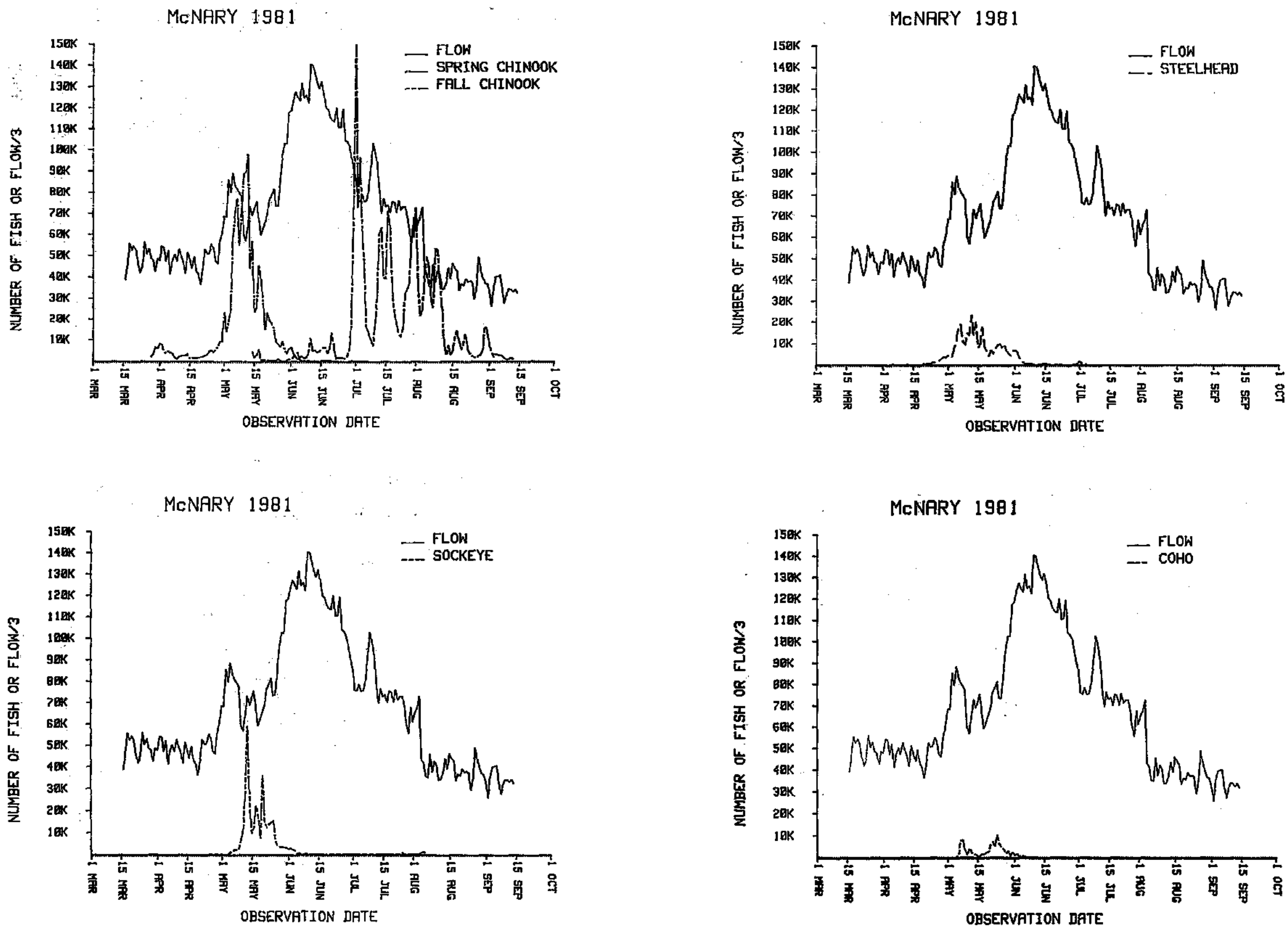


Figure 8.--Columbia River flows versus daily counts of juvenile spring chinook, fall chinook, steelhead, sockeye, and coho during 1980 at McNary Dam.

Figure 9.--Columbia River flows versus daily counts of juvenile spring chinook, fall chinook, steelhead, sockeye, and coho during 1981 at McNary Dam.



Pacific storms eventually brought rains to the region in the latter part of the month and flows began reflecting the increased precipitation on April 20. Continuing storms caused steadily increasing daily average flows which peaked on May 2 and 3 at 130.5 kcfs. The region experienced a second dry period during the first three weeks of May, and combined with the limited snow pack, reduced the Snake River flows to a level of 51.7 kcfs by May 20. Storms returned in rapid succession for the remainder of May and June, and flows jumped upward peaking again on June 10 at 176.1 kcfs, after which it began a steady downward trend.

Involuntary spill, or spill caused by reduced power demand, occurred at Lower Granite from April 27 to May 5 and from May 26 to June 24. The first period spill averaged 19 percent and ranged up to 31 percent. During the second period, spill averaged 26 percent and ranged up to 60 percent of total flow. Little Goose spilled from June 5 through June 16. During that period, spill averaged 29 percent and ranged up to 51 percent of flow. The percent daily spill is included for both projects in Appendix Tables 1 and 2. Spills were greater at Lower Granite as only 4 turbine units were on line early in the season. Two units (3 and 5) were being repaired. From late May through the end of the transport season, Lower Granite had 5 operable turbine units. The powerhouse at Little Goose had 6 units operating the entire season.

Columbia River

The dry winter caused below normal runoff conditions in the Columbia River early in 1981. Although the runoff forecast was below normal, the outlook was not as bleak as for the Snake River. The March 1 forecast made by NRFC predicted 85 percent of normal runoff at Rock Island Dam and 77 percent at The Dalles Dam.

The periods of rain paralleled that described for the Snake River. Peak flow periods were also similar. Flows peaked at McNary on May 4 at 265.7 kcfs and again at 421.9 kcfs on June 9.

Involuntary spill occurred at McNary Dam from May 3 to 12, May 26 to June 30, and July 3 to 12. Spill averaged 8 percent the first period, 46 percent the second period, and 10 percent the last period (Appendix Table 3). Power demand in many cases affected daily periods of spill. Several times during the season spill at night approached 100% of total flow and during the day was reduced. This spill pattern reduced the number of smolts collected during this period because peak migration times occur in the early evening and predawn hours.

TRANSPORT VEHICLES

The transport program is presently conducted so maximum numbers of migrating salmonids are collected and transported safely to below Bonneville Dam for release. The transportation mode incorporates trucks early and late in the season. Barge transport is used during the peak spring migration period with trucks filling in as needed.

Five truck tractors were available for hauling fish, three leased and two Corps owned. All five fish trailers are Corps property. Capacity of the truck tankers is 3500 gallons. The current criteria of 0.5 lb fish per gallon of water allows a maximum 1750 pounds of fish per load. Truck transport began on March 30 and ended September 11. Juveniles trucked downstream were released at the Bradford Island site located at the north end of Bonneville Dam first powerhouse.

Three barges were available for transporting fish this season, which reduced the holding period and densities in the raceways. These barges have a volume of 85,000 gallons of water with a 5200 gpm flow. Criteria for barge loading was 5 lbs fish per gpm flow with a maximum 26,000 pounds of fish per load. Barge releases were made near the Skamania light buoy, approximately 5 miles downstream from Bonneville Dam. The first barge load of fish departed Lower Granite on April 22 and the last load departed McNary on June 14.

Two new barge operations were tried this year. On one trip two barges were towed together. The barges were not equipped with push knees (bumpers) and winches so they had to be towed side by side instead of in tandem, which slowed the journey. This type of operation could allow greater numbers of fish to be transported every other day during a time when only two tugs are in operation. The second operation occurred in early June. At that time collection numbers were low on the Snake River projects and barging was no longer feasible. Snake River fish were then trucked to McNary and loaded onto a waiting barge. This operation reduced both truck transport time for smolts and operational costs; however, it did increase handling of these smolts.

Transport Mortalities

NWAFC personnel at Bonneville Dam met the fish transport trucks during the spring period, April 6 through June 22, 1981. They, along with transport drivers, made surface counts of mortalities and then estimated numbers of mortalities as the releases were being made. After June 22, only the estimates from truck drivers were used.

Mortalities were higher for barged chinook in 1981 (1.27%) as compared to 1980 (0.56%). Total barge mortalities for steelhead were lower in 1981 (0.016%) than in 1980 (0.047%). Two barge loads taken at the peak of the migration (May 3 and 5) accounted for 67.7 percent of total barged chinook mortalities. The highest immediate mortality coincided with the highest loading densities. However, we believe the primary cause of death was more closely related to condition of smolts arriving at the projects. Preloading stress and descaling were highest at these times. More than 90% of the mortalities removed from the barge compartments showed serious descaling. During this period, water and debris conditions at the projects were less than favorable. Spring storms loaded the river with floating debris and high muddy water, which inundated the Snake River collection facilities with smolts. During years past, increased descaling rates have coincided with peak periods of flow and collection.

1981 JUVENILE OUTMIGRATION

The 1981 transport season was the longest on record. The total number of smolts collected and transported under the program was also the highest ever (8,308,850). While record numbers of smolts were transported, the Snake River accounted for a smaller percent of the total. Transported smolts at McNary set a record this year (4,112,993), more than twice the previous high level in 1980. Table 1 shows numbers of smolts transported at each project by species and transport mode. The transported totals from 1978 to 1981 are shown on Table 2 and the mode of transport and totals on Table 3.

The composition of the juvenile outmigration from the Snake River changed in 1981. This was the first year since 1974 when the estimated chinook outmigration reaching the upper dam was smaller than the steelhead estimate. The total number of juvenile outmigrants arriving at Lower Granite was estimated to be 3,200,000 chinook salmon and 3,900,000 steelhead trout [2/]. The number of chinook salmon and steelhead smolts arriving at the upper dam, and the number and percent transported for years 1971-81 are shown on Table 4. In addition, 1981 was one of the smallest chinook migrations recorded in the last 10 years. The number of chinook transported was less than half that of 1980. The Snake River steelhead outmigration was above average and near last year's estimate. The number transported approached 1980's record level.

Submersible Traveling Screens (STS's)

Screens at each project were operated for a longer time period than in previous seasons; in most cases a month additional time. Year-end inspections indicated sprocket and chain wear on all screens. The NPW requested, and fishery agencies agreed to, an on-off operation for screens to coincide with turbine unit outages which may be adopted next season. The feasibility of intermittent operation of screens will be tested by NWAFC research personnel in 1982. Both of these concepts should reduce wear on the screens. New screen mesh will incorporate straight rather than notched screen margins. Maintenance on screen mesh should be greatly reduced in future seasons.

2/ Sims, Carl W. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, Washington 98112 (Pers. Commun.).

Table 1.--1981 Juvenile Fish Transport Summary and Dates of Operation

	Trucked	Barged	Total
Lower Granite	April 3 - July 30		
Chinook	232,543	642,323	874,876
Steelhead	156,246	1,699,744	1,855,990
Total	388,789	2,342,077	2,730,856
Little Goose	April 10 - July 25		
Chinook	211,630	372,681	584,311
Steelhead	106,012	774,668	880,680
Total	317,642	1,147,349	1,464,991
McNary:	March 27 - September 11		
Spring Chinook	286,476	946,577	1,233,053
Fall Chinook	2,031,925	69,196	2,101,121
Steelhead	77,109	290,211	367,320
Coho	12,851	89,755	102,606
Sockeye	31,198	277,695	308,893
Total	2,439,559	1,673,434	4,112,993

Trucked total	3,145,980
Barged total	5,162,860
Transport total	8,308,850

Table 2.--Transport summary by dam of juvenile fish collected from 1978 through 1981.

	Lower Granite	Little Goose	McNary	Total
1978	1,980,600	996,285	82,211	3,059,906
1979	2,367,446	1,453,615	1,247,120	5,068,181
1980	3,830,747	2,282,987	1,740,545	7,854,279
1981	2,730,866	1,464,991	4,112,993	8,308,850

Table 3.--Transport summary of total juvenile fish trucked or barged from the collector facilities, Lower Granite, Little Goose, and McNary Dams from 1978 through 1981.

	Trucked	Barged	Total
1978	1,580,724	1,478,372	3,059,096
1979	2,031,212	3,036,969	5,068,181
1980	3,019,232	4,835,047	7,854,279
1981	3,145,980	5,162,860	8,308,850

Table 4.--Number of chinook salmon and steelhead smolts arriving at the upper dams on the Snake River and the number and percent of the total Snake River outmigration transported below Bonneville Dam 1971-1981 (includes experimental fish marked for transport evaluation).

Year	Chinook smolts No. at upper dam (1,000)	Chinook smolts No. hauled (1,000)	Chinook smolts Percent hauled	Steelhead smolts No. at upper dam (1,000)	Steelhead smolts No. hauled (1,000)	Steelhead smolts Percent hauled
Transport from Little Goose Dam						
1971[a/]	4,000	109	3	5,500	154	3
1972	5,000	360	7	2,500	227	9
1973	5,000	247	5	5,500	176	3
1974	3,500	0	0	5,000	0	0
Transport from Lower Granite and Little Goose Dams combined						
1975	4,000	414	10	3,200	549	17
1976	5,000	751	15	3,200	435	14
1977	2,000	1,365	68	1,400	895	64
1978	3,180	1,623	51	2,120	1,355	64
1979	4,270	2,109	49	2,550	1,712	67
1980[b/]	5,600	3,254	58	3,600	2,860	79
1981[c/]	3,200	1,459	46	3,900	2,737	70

a/ Data for years 1971-79 from Smith et al. (1980).

b/ Number of smolts estimated at upper dam from Sims et al. (1981)

c/ Number of smolts estimated at upper dam from Sims per. comm.

Counting

All fish entering the holding facilities pass through 4 inch electronic counting tunnels and are automatically counted. This is a continuous, 24 hour per day process and provides information on total fish collection. Approximately 5 percent of the total collection was diverted hourly into a sample raceway. These fish were counted electronically and then hand counted during the sampling process. Preliminary analysis of the automatic counts from Lower Granite, compared with hand counts, revealed an inconsistency between the two (see page 33). If counter error (undercount) was a problem, then the possibility exists that total raceway holding densities and total fish collection was greater than recorded.

Quality Control

Descaling is a criterion for determining fish quality at each collector project. To determine the percent descaling on a fish' body, a system to divide the individual's length into approximately ten equal areas (five on either side), was established by NWAFC personnel. In order to be classified "descaled", scales must be missing from two or more of those areas. Daily samples were taken from 100 individuals of each species whenever possible (Figure 10).

SUMMARY OF FISH TRANSPORTATION AND OUTMIGRATION

Operation wise, 1981 was a successful transportation season. Many improvements to the O&M procedures of Operation Fish Run were made. The projects experienced and handled almost every kind of collection condition imaginable, from drought to floods, clear unlimited water visibility to muddy, two-inch water visibility , and poor to good fingerling condition. Efforts were continued at reducing stress levels and improving holding and transport conditions. Mechanically speaking, 1981 was a smooth year, also. Communications and cooperation among Corps, NMFS, and state personnel were excellent.

Figure 10.--A sample form used for recording descaling data at collector facilities.

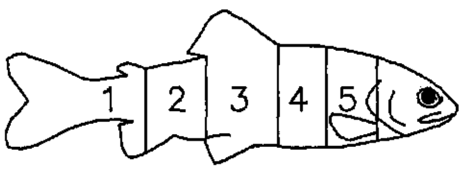
DESCALING DATA
LITTLE GOOSE DAM– 1981

RECORDER ____________ SLOT ____________ DATE ____________

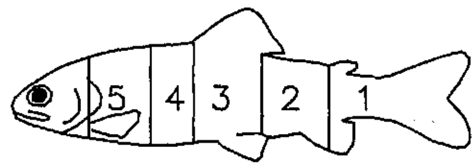
RIVER ____________ FOREBAY ____________

TIME: DIPPED ____________ EXAMINED ____________

RIGHT



LEFT



6. SCATTERED 7. EYE/HEAD INJURIES 8. DEAD

OK	DESCALED CHINOOK				OK	DESCALED STEELHEAD			
1					1				
2					2				
3					3				
4					4				
5					5				
6					6				
7					7				
8					8				
9					9				
10					10				
11					11				
12					12				
13					13				
14					14				
15					15				
16					16				
17					17				
18					18				
19					19				
20					20				
21					21				
22					22				
23					23				
24					24				
25					25				

TOTAL FISH SAMPLED ________ TOTAL FISH SAMPLED ________

TOTAL DESCALED ___ % DESCALED ___ TOTAL DESCALED ___ % DESCALED ___

Snake River

Although the transport process in itself was very successful during this transition season, the outlook for adult returns from this year's migration is not encouraging for Snake River spring chinook. Poor fish quality was reflected in high descaling rates, 15.5%, Lower Granite, and 13.5%, Little Goose, and resulted in subsequent mortalities in the raceways, barges, and trucks. Mortalities ranged from 0.6% to 1.7% of the chinook held or transported.

The combined low numbers of migrating chinook (3.2 million), and the poor quality smolt that arrived at the projects make the authors concerned about ensuing adult returns. We do not consider the collection and transportation process the major problem that caused the poor fish condition, but rather, the lack of adequate flows (less than 85 kcfs) from May 7 through May 21 (critical segment of the migration). In addition, high flows were associated with high suspended sediment and debris loads during peak migration periods. These factors, combined with increased levels of descaling, caused a significant portion of the migrating population to be in a highly stressed condition when they reached the collector dams.

It is the opinion of the authors that a juvenile sampling program should begin in the upper end of the Lower Granite reservoir. In order to fully understand and describe the stresses and physical effects caused by collection and bypass, biologists need to know the condition of migrants as they enter the reservoir.

Steelhead migrants were plentiful in number and appeared healthy and vigorous. However, the steelhead from the Snake River system were also highly descaled, in excess of 11.4%. Even though mortality estimates did not demonstrate a strong correlation with descaling rates, insufficient data exist to determine whether juvenile steelhead migrants suffer the same mortalities as experienced by descaled juvenile chinook. Steelhead were not subjected to sea water challenge tests as were chinook salmon.

Columbia River

The spring migration had a large increase in numbers of transported fish. Preliminary data from transport evaluations have generally shown positive transport benefits. Further tag recoveries in subsequent years will be needed to substantiate the preliminary findings.

The fall chinook salmon had descaling and mortality rates of 4.3% and 1.9% respectively. These figures are higher than in previous migration seasons. Since marked transported/control tests from McNary are still incomplete, no definitive estimates can be given as to how well the fall chinook migrants can be expected to return as adults.

Future Transport Operations

Future operations at the transport projects should improve as stress related problems are identified and eliminated, and new changes/modifications are incorporated into the collection system. Fishery agencies and the Columbia River Inter-Tribal Fish Commission are currently reviewing transportation data and are in the process of making recommendations as to future transport operations.

TRANSPORT OPERATIONS - LOWER GRANITE DAM

Collection of Juveniles

The 1981 fingerling collection system began operating on April 2 and continued on a 24 hour/day basis through July 30. All turbine intakes were screened in 1981. Project personnel began placing STS's into position on March 30 and watered up the bypass system on April 2. The first juveniles were transported on April 3. Matthews et al. (1977) described the collection and bypass system at Lower Granite. Few changes have been made since 1975. Mechanically, the 1981 transport season was similar to 1980 except for the following modifications:

1. The STS's were all modified prior to the transport season. By lengthening the frames, screens were lowered to meet the designed throat, gap and overlap criteria (Fig. 11).

2. The intake trash rake was installed and made operational. The rake was used extensively to clean debris accumulated on the trash racks.

3. A pressurized distribution system, with air operated gates, was installed by NWAFC and used in 1981. As a result, sampling was altered significantly. Instead of manually switching the 4 inch pipes to feed the sample raceway, the air operated system allowed the raceway operator to sample 3-6 minutes hourly with minimum effort.

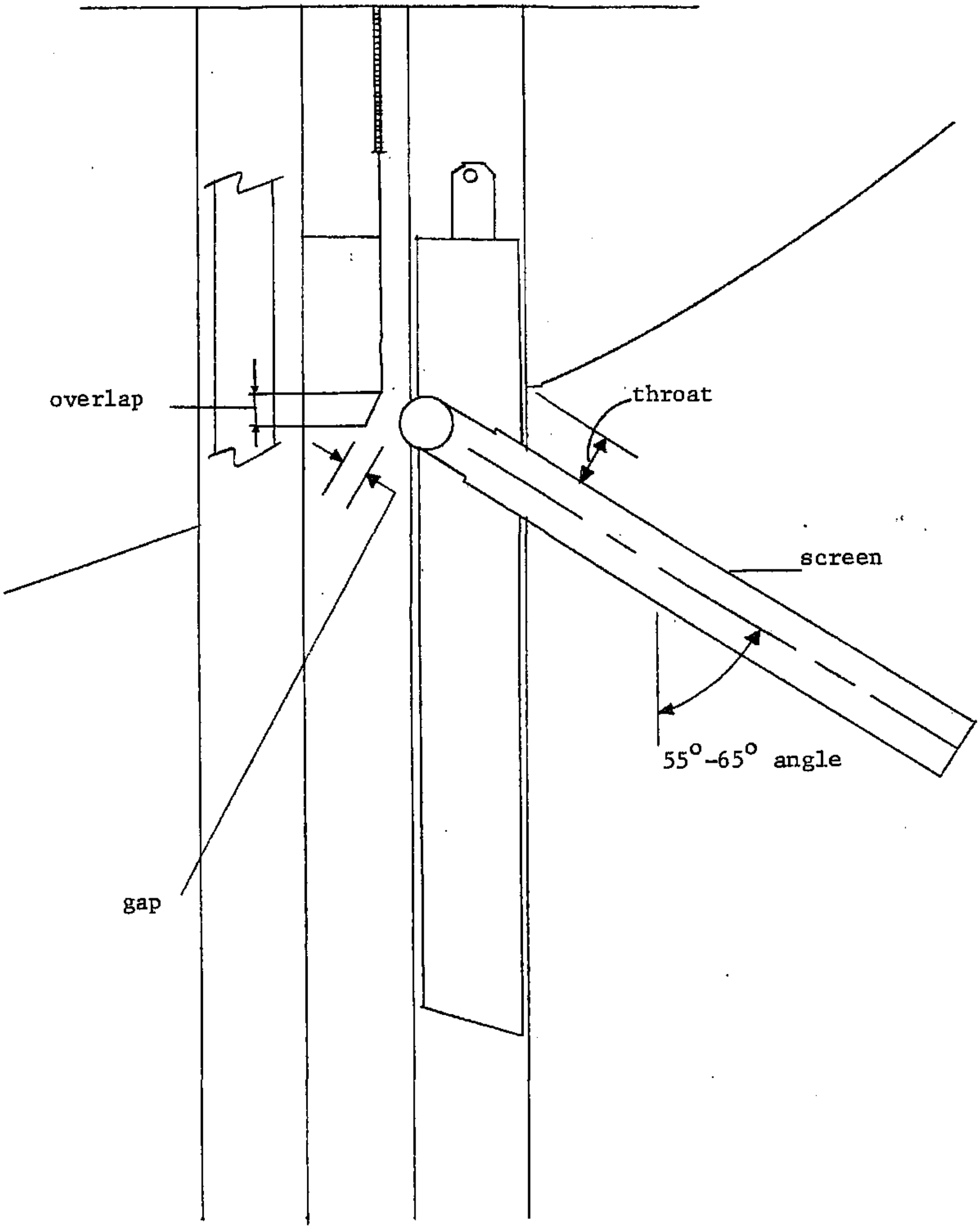
4. Major modification was completed on the hopper under the separator in 1981. NWAFC redesigned the hopper to alleviate the hydraulic problem, (i.e., fish exiting through primarily two of the four orifices), and subsequent undercounts observed in the previous year.

5. The upstream gallery orifices were equipped with slidegates to simplify the orifice cycling procedure.

6. The "restrictor rings" in the bypass transport pipe were not used.

Juvenile chinook salmon and steelhead trout were present during the entire collection season, April 3 through July 30. The peaks in the juvenile out-migration reflected the peak flow periods (Fig. 6). Chinook salmon smolts peaked twice during the season, once at 78,000 on April 27 (89.4 kcfs) and again at 66,000 on May 3 (130.5 kcfs). Steelhead trout displayed three major peaks and two minor increases throughout the season: 49,000 on April 28 (96.1 kcfs); 189,000 on May 3 (130.5 kcfs); 83,000 on May 10 (66.0 kcfs); 91,000 on May 23 (107.6 kcfs) and 22,000 on June 6 (121.3 kcfs).

Figure 11.--Submersible Traveling Screen in operating position showing gap, throat, and overlap.



On April 30 a severe thunderstorm hit the Palouse region near Julietta, Idaho, causing local flooding and massive soil losses. It was estimated by the U. S. Soil Conservation Service that in some localized areas the erosion loss was as high as 100 to 300 tons of topsoil per acre [3/]. Severe sediment loads entered the Potlatch, Clearwater and Snake Rivers. The resultant turbid, high flows entered Lower Granite reservoir and quickly moved the smolts holding in the reservoir, due to low flows, downriver in mass.

The juvenile smolts arrived at Lower Granite on the crest of the freshet during the afternoon of May 3 resulting in the peak collection day of 255,000 juveniles. This crest subsequently reached Little Goose Dam on May 5 when over 238,000 fish were collected. Barges were dispatched from Lower Granite Dam on May 3 and 5, and fish were transported with little loss, except as listed for spring chinook on page 15 of this report. Turbidity dropped to 0.2 feet, and fish were highly descaled during the peak flow and fish collection period.

Migrating juveniles were counted via electronic fish counters as they exited from the fingerling separator and into the holding raceways. Over 2.7 million juveniles were counted into the collection facilities during the 1981 transport season (Appendix Table 1). Transported fish totaled 2,730,866 with barges accounting for an estimated 2,342,067 and trucks 388,789 (Table 3). These figures include marked fish for truck and barge experiments and are summarized in Appendix Table 4. Collection was calculated at Lower Granite to be 28.3 percent for chinook and 48.7 percent for steelhead. This was determined by using NWAFC estimated outmigration arriving at Lower Granite of 3.2 million and 3.9 million chinook and steelhead, respectively.

The different modes of transportation came in and out of use as the peak migration period arrived. At Lower Granite, all juveniles were trucked between

3/ Houska, Kenneth, U.S. Soil Conservation Service Field Station, Moscow, Idaho 83843 (Pers. commun.).

April 3 and April 21. During this period fish counts went from 1,200 to 28,400 fish per day (Appendix Table 1). Approximately 103,539 fish were trucked during the first three weeks of operation, which accounted for 11.2% of the total chinook and 0.03% of the steelhead transported (Table 5). The early trucking phase accounted for 3.8% of the entire transport population from Lower Granite. Fish collected at Lower Granite were transported by barge between April 22 and June 3 during which time fish counts remained above 20,000 per day. During the same period, some 49,000 juveniles were trucked between Lower Granite and Bonneville for research purposes. An estimated 2,342,067 juveniles were barged during the 6-week peak migration. This accounts for approximately 86% of the total transported, and 73.4% and 91.6% of the spring chinook and steelhead respectively. After the peak migration period, juveniles were transported via truck from Lower Granite to McNary Dam, where they were loaded onto a waiting barge. This phase lasted approximately 10 days, from June 4 to 14, and accounted for 4.3% of the transport total and 3.5% and 4.7% of the total spring chinook and steelhead respectively. From June 15 until the facility terminated operations on July 30, juveniles were trucked. During this 6-week period, 117,946 fish were transported, or 4.3% of the total hauled. Approximately 67% were chinook (78,970) and 33% steelhead (38,970) which accounted for 9.0% and 2.1% of their respective totals.

Approximately 60,100 fall chinook smolts which had been raised at Hagerman National Fish Hatchery were released directly into the facility raceways at Lower Granite. They were allowed to voluntarily migrate from the raceways and were subsequently barged below Bonneville Dam. These chinook smolts were not included in the collection and transport totals since they had not been collected at the project.

Facility and O&M

Prior to the juvenile migration season, the forebay area was cleared of debris and the intake trash racks raked of accumulated debris. A newly-installed trash rake allowed the removal of debris which had been collecting since Lower Granite started operation in 1975. During the 1979 outmigration, a massive accumulation nearly blocked the upper third of the trash racks in front

Table 5.--Numbers and percent of juvenile salmon and steelhead by transport mode and migration period during the 1981 transport season at Snake River collector dams.

Transport vehicle	Transport period	Nos. chinook	Percent chinook	Nos. steelhead	Percent steelhead	TOTAL	% of chinook total	% of steelhead total	% of total transported
LOWER GRANITE									
Truck	Apr. 3-21	98,232	94.9	5,307	5.1	103,539	11.2	0.3	3.8
Barge	Apr 22-Jun 3	642,323	27.4	1,699,744	72.6	2,342,067	73.4	91.6	85.8
Truck[1/]	Apr 22-Jun 3	25,000	51.0	24,000	49.0	49,000	2.9	1.3	1.8
Truck & Barge[2/]	June 4-14	30,339	25.6	87,965	74.4	118,304	3.5	4.7	4.3
Truck	Jun 15-Jul 30	78,972	67.0	38,974	33.0	117,946	9.0	2.1	4.3
Total		874,866		1,855,990		2,730,856	100.0	100.0	100.0
LITTLE GOOSE									
Truck	Apr 16-May 7	106,287	75.6	34,363	24.4	140,650	18.2	3.9	9.6
Barge	Apr 26-Jun 4	372,681	32.5	774,668	67.5	1,147,349	63.8	88.0	78.3
Truck & Barge	Jun 5-14	44,822	47.6	49,330	52.4	94,152	7.7	5.6	6.4
Truck	Jun 15-Jul 25	60,521	73.1	22,319	26.9	83,840	10.3	2.5	5.7
Total		584,311		880,680		1,464,991	100.00	100.0	100.0

1/ Trucked specifically for research study.
2/ Trucked to McNary and loaded on barge for transport below Bonneville Dam.

of Units 1 and 2. A floating crane was eventually able to remove a significant amount during the transport period 4/. In the 1980 season, Lower Granite used a large steel beam to push accumulated debris to the bottom of the trash racks. In 1981, trash raking was initiated on February 11 and continued into late March, until all materials (5-year accumulation) had been removed from the trash racks.

Throughout the fish migration period, the project was inspected for trash buildup and/or gatewell drawdown. The period of high flows in late April-early May brought large amounts of new debris into the forebay. Trash raking was resumed and racks were found covered with tumbleweeds and other debris (Figure 12). Raking was continued as necessary during the remainder of the transport season. The more efficient method of removing debris resulted in much less gatewell turbulence for units 1, 2, and 3, compared to recent years. The rolling boils in these slots were eliminated and replaced by the softer motions normally seen in Units 4, 5, and 6.

Although debris accumulation on trash racks was handled in a much more satisfactory and efficient manner in 1981, the removal of gatewell debris was at times a problem (Figure 13). After the first week in April, a steadily increasing amount of debris entered the gatewell and bypass system which may have resulted in increased fish stress and injury. The Corps, due to manpower restraints and priorities, did not dip gatewells as frequently as needed, especially early in the season. This area should receive a higher priority in the future.

During 1981, the Project continually removed floating debris from the forebay. Floating material was collected with a small section of a log boom

4/ Smith, J.R., Matthews, G.M., Basham, L.R., Achord, S., McCabe, G.T. January 1980. Transportation operations on the Snake and Columbia Rivers 1979. Final report to the U.S. Army Corps of Engineers. Contract No. DACW68-78-C-0051-Operations. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, Washington 98112 (28 p. 16 tables).

Figure 12.--Trash rake and debris at Lower Granite Dam, 1981.

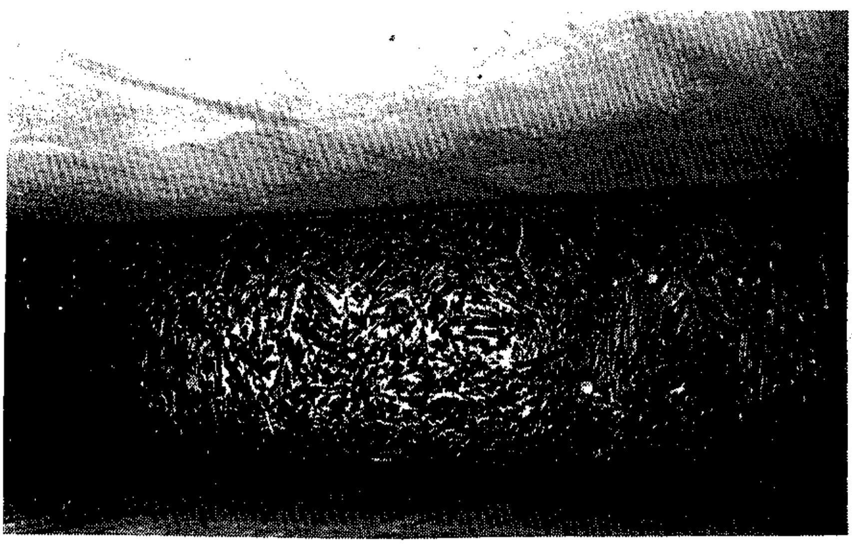


Figure 13.--Floating Debris in gatewell at Lower Granite Dam.

and removed from the forebay with a crane and clamshell. The debris boom, scheduled for installation for 1982, may eliminate the necessity for trash skimming immediately in front of the turbine intakes.

The newly-modified STS's were placed into the bulkhead slots on March 30 and 31. Only 4 units were operational at the beginning of the migration season. Unit 3 was never put on line and Unit 5 did not become operational until May 20. As previously mentioned, existing screens at Lower Granite had been determined to be deficient in their throat, gap, and overlap specifications. Modifications were completed which should increase both guiding and collection efficiencies. The rate of fish screen mesh deterioration at Lower Granite accelerated during the 1981 migration. Lower Granite's STS's have been in use since 1975/76 and have been steadily deteriorating each season. Maintenance has increased with aging of the screens. Mesh deterioration has been determined to be a factor of: an increased operating season, age of screen mesh, trash accumulation, screen chain wear, and the notched screen margins.

A video inspection procedure was initiated by the Project to periodically monitor the STS's. Turbine units were shut down, and by lowering a video TV camera into the gatewell slots, screens could be examined while turning in place. This procedure proved very successful. Damaged screens were readily noticeable, and repairs accomplished in a timely fashion. Video inspection enabled detection of a wide range of screen damage, from small mesh tears along the marginal belts to complete sectional failures (Figures 14 & 15). Video inspections occurred on the following dates: April 23 and 24, May 18 and 20, June 8 and 9, and on July 20 and 21.

Approximately 33 hours of out-of-service time on generators occurred during video inspections at Lower Granite. Unit outages to remove damaged screens and install repaired screens totaled 54 hours. Screens that were in service but not rotating totaled 29 hours and were all, but for one instance the result of moisture probe detector failures. When the STS's were pulled at the conclusion of the transport season and inspected, excessive wear was noted on the drive chain track, sprockets, and bearings. The Project is attempting to have these screens repaired under an existing contract.

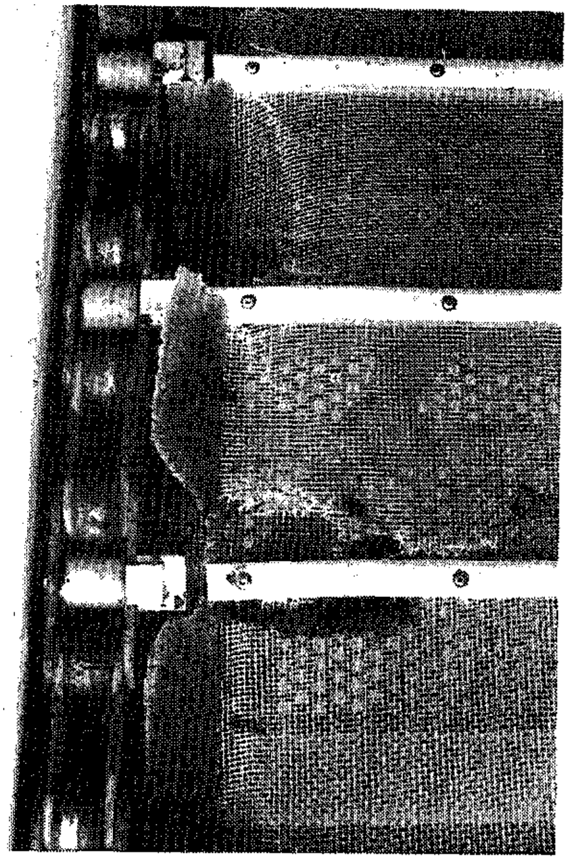


Figure 14.--Small tears in the Submersible Traveling Screen mesh along the margins.

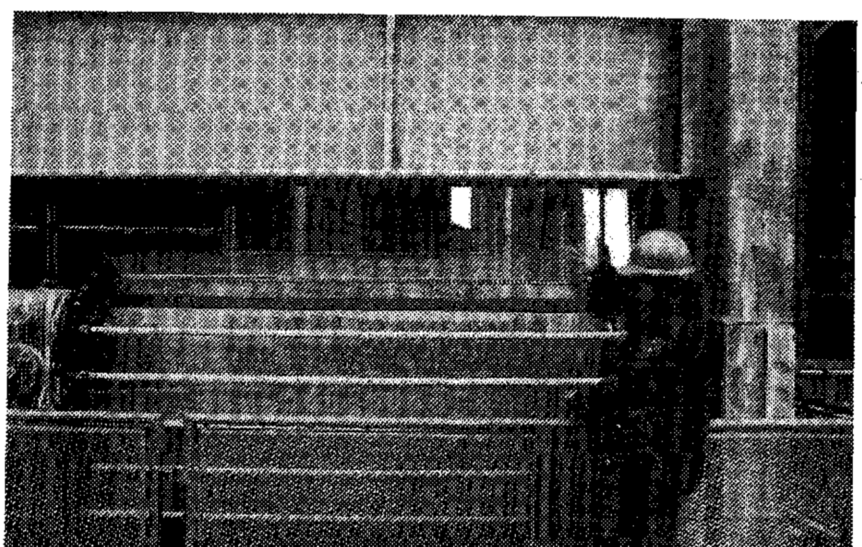


Figure 15.--A complete sectional tear on a Submersible Traveling Screen.

At one point the Vertical Barrier Screen (VBS) in gatewell 1A was monitored. Because the camera was not fixed to a frame, the unit had to be shut down for the monitoring. The results indicated that, in a dead unit at least, trash did not tend to accumulate on the VBS.

The separator used was a modified dry type operated initially in 1980. Modification of the separator hopper and installation of a pressurized distribution system were the only major changes to the bypass system at Lower Granite in 1981. The new hopper was designed to eliminate counter error which had previously resulted from juveniles exiting from only 2 of the 4 hopper exits, especially during peak migration periods. The new distribution system (Figure 16) was designed by NWAFC to:

1. Allow quick and accurate operation by a single worker.

2. To increase sampling frequency and accuracy.

3. Reduce the tendency for juvenile fish to jump at the surface disturbance caused by water falling from the counting tunnels.

4. Reduce the "delay" period of juveniles in the distribution system.

The new system operated successfully throughout the 1981 migration season, but counting errors still plagued the collection facility. During a portion of each hour (usually 2 to 3 minutes) all fish were diverted into a sample raceway. The sample fish were electronically counted and subsequently hand counted while being sorted by species each day. Following the 1981 transport season, project personnel looked at counting procedures. The expanded hand count was compared with the total electronic counts and expanded electronic counts from the sample raceway. Results indicated possible inconsistency in the electronic counts. Expanded hand counts averaged 35.6% higher than the total electronic counts and 12.0% more than the expanded sample raceway electronic counters. Expanded hand counts ranged from 51.1% less than to 318.0% more than the total electronic counts. In addition, expanded hand counts ranged between 78.4% less than to 318.3% more than the expanded sample

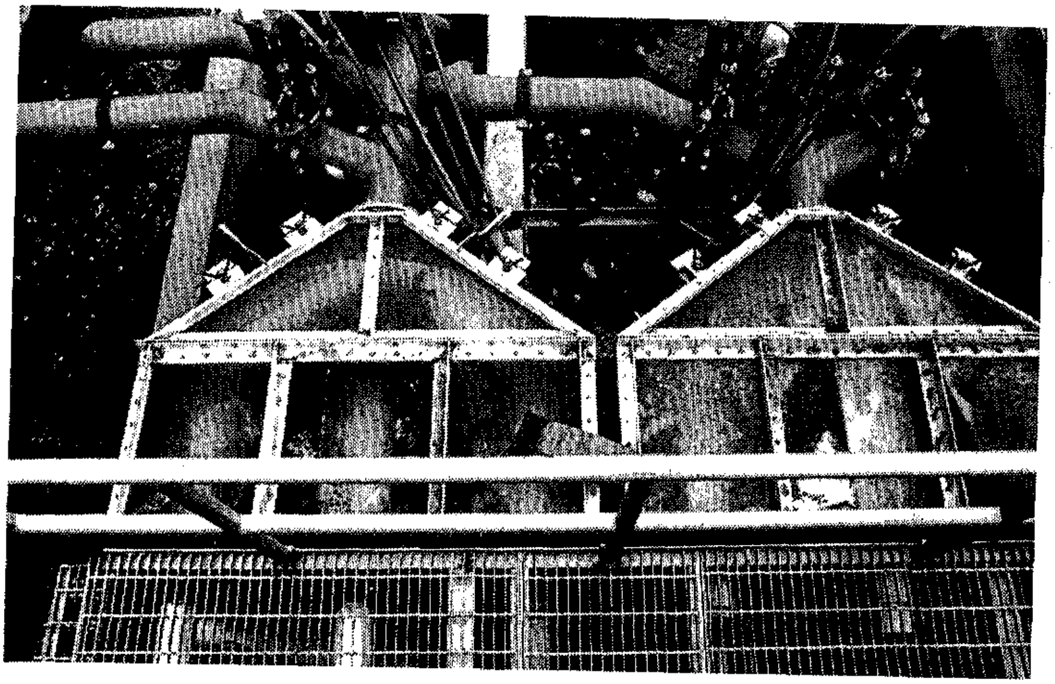


Figure 16.--Fingerling distribution system at Lower Granite Dam.

raceway electronic count. Possible sources of error in the above figures may be due to:

1. The recorded time was different from the actual sample time.

2. Personnel neglecting to turn on or off the sample raceway counters when the fish were diverted into the sample raceway.

3. Sensitivity of the counters was set too low.

4. Two or more fish passed through the counting tunnel at the same time and were counted as one fish.

5. Fish that have been counted into the holding raceways held in the distribution manifold and then were flushed into the sample raceway during the sampling period.

6. There may have been an error in the hand count.

FTOT believes a comparison between the expanded hand count and expanded sample raceway electronic count is more valid (12% error). This assumption is based on the fact that each sample was 2, 3, 4, 5, or 6 minutes in length while in fact the true length of time was never recorded. Any sampling error would be treated equally when comparing expanded sample raceway electronic and hand counts. Conversely, when the total electronic count is compared to the expanded hand count no timing error could be taken into consideration.

The Transportation Operations Report for FY 1980 to the NPW shows that electronic counts were not 100 percent accurate. If there was an undercount of 12 percent, it is possible that approximately 336,642 more fingerlings were collected and transported than project counts indicated.

Descaling

During the 1981 juvenile migration, fish were sampled for rates of descaling between the periods of April 10 and June 30. Rates of descaling were kept for both chinook and steelhead, and averaged 15.4 percent and 16.8 percent, respectively. Except for the 1977 migration, averages were the highest recorded at Lower Granite. Chinook descaling ranged from 3.8 percent to 47.7 percent while steelhead ranged from 0.0 percent to 38.7 percent during 1981. During the previous migration in 1980, chinook descaling averaged 4.0 percent and steelhead 8.2 percent and ranged from 1.0 percent to 11.0 percent, and from 1.0 percent to 24.0 percent, respectively. Descaling for both species fluctuated considerably but was highest between mid-May and mid-June. Preliminary stress related research (salt challenge bio assay at 30 parts per thousand (ppt) salt water) conducted by NWAFC workers at Lower Granite, showed a strong correlation between mortality and descaling. During the bio assays, 78 percent of the descaled fish did not survive the seawater challenge [5/].

Fish Facility Mortalities

Fish mortalities were less in 1981 as compared to 1980, 0.3% to 0.6% respectively. Mortality rates by species for the 1981 season were: steelhead, 0.1%, chinook, 0.7%. Daily mortality totals and percentages for both species are found in Appendix Table 1. Steelhead daily mortalities remained less than 1.0% until June 22nd. During this period, daily rates ranged between .01% and 0.8%. Although descaling rates were generally higher than normal, facility mortality remained low until water temperatures began climbing in late June. Comparisons for late season mortalities at Lower Granite are not available since the collection season in 1981 continued longer than in previous migrations. After June 23, daily steelhead mortality rates ranged between 0.2% and 23.8%. These higher rates generally reflected the poorer condition of steelhead arriving at the project.

Juvenile chinook mortalities ranged somewhat lower than steelhead in 1981, but their seasonal average was approximately 7 times higher. During April and May, daily mortalities ranged between 0.04% and 2.3%. Daily mortality rates remained less than 1.0% except for the first few days after the bypass system began operating and on several days during the peak migration. The initial

5/ Matthews, G.M. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, P. O. Box 267, Clarkston, Washington 99403 (Pers. commun).

high counts may have resulted from poor quality chinook that had spent considerable time in the forebay and gatewells prior to collection. During June and July, when fall chinook enter the collection system in greater numbers, mortality rates ranged from .02% to 9.0%. The steadily increasing chinook mortality in July was most likely due to escalating river temperatures.

TRANSPORT OPERATIONS - LITTLE GOOSE

Collection of Juveniles

By April 7, numbers of fish arriving at Lower Granite Dam exceeded 2,000 per day and the Little Goose collection system, including a new wet separator was placed in operation. Fish collection continued until 24 July when high water temperatures, low fish numbers, and rising mortality rates made collection no longer viable. All 18 turbine intakes were screened, 13 with new traveling screens and 5 with older screens, placed in gatewell slots 5B and C and 6A, B and C.

On April 13, some pieces of concrete lining from the 42 inch bypass pipe were found on the wet separator and the collection facility was shut down. Upon inspection of the pipe, it was determined that using the newly-installed pinch valve had created cavitation that caused damage to the inner lining of the pipe. It was therefore concluded that the pinch valve should not be used for the remainder of the season. The pipe was repaired, and the system was watered up again on April 15. However, high mortality rates persisted and the facility was shut down once again on April 21; this time to modify the make-up water supply system. The water diffusion baffles were replaced with a plate to direct the make-up water so that it mixed smoothly with the collection channel flow. NWAFC studies in 1980 had revealed that significant chinook mortality probably resulted from a shear plane effect at the interface of the collection channel and make-up water [6/]. On April 23, the system was watered up again.

6/ Park, D.L., Harmon, J.R., Monk, B.H., Ruehle, T.E., Newcomb, T.W., Basham, L.B., Flagg, T.A., October 1981. Annual report to U.S. Army Corps of Engineers, Contract No. DACW68-67-C-0051. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 2725 Montlake Boulevard East, Seattle, Washington 98112 (45 p., 26 tables).

Descaling and mortality rates were lower and fish condition was improved although surging problems existed in the system.

Problems prior to April 20 actually affected low numbers of fish. Daily collection ranged from 34 to 553 smolts and totaled 1,617 between April 10-20. Immediately after the facility was watered up on April 23, collection was up to 6,300 and thereafter continued increasing.

The most significant mechanical change in Little Goose collection facilities in 1981 was the conversion to a wet separator (Figure 17). The wet separator had the following advantages over dry-type separators: 1) the fish are always in their natural environment and are not exposed to air; 2) stress should be reduced because of the above reason; and 3) floating debris should automatically be carried over the end of the separator. Fish exited the upwell into 2 to 3 inches of water over the separator bars and volitionally sounded through the bars to get into the hopper. From the separator hopper they exited through six 4 inch electronic counting tunnels, similar to tunnels used in 1980. Fish often accumulated over the separator bars where they remained for some variable and undetermined length of time before sounding. Separation of the smaller size group was poor until the bars were modified from a 3/4 inch to ½ inch size opening. Until the modification, there was a nearly equal distribution of small fish between the two hoppers. NWAFC personnel from May 12 to 19 conducted a test to determine hopper distribution of chinook salmon. Their results showed chinook fingerling separation to be 80% in the smaller grade hopper and 20% in the larger grade hopper [7/]. A problem existed with the overflow at the downstream end of the separator. Large steelhead smolts, particularly the large Idaho hatchery smolts, commonly passed over the end of the separator and were never collected. A hanging rubber barrier was added to provide a visual blockage; however, many of the larger steelhead smolts still either passed over the end or were physically removed because they were too large to fit through the bars. Upon recommendation by the FTOT, bar spacing for 1982 will be increased from 1¼ inch to 1½ inch to accommodate the larger smolts.

7/ Smith, J.R. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, P.O. Box 267, Clarkston, Washington 99403 (Pers. commun).

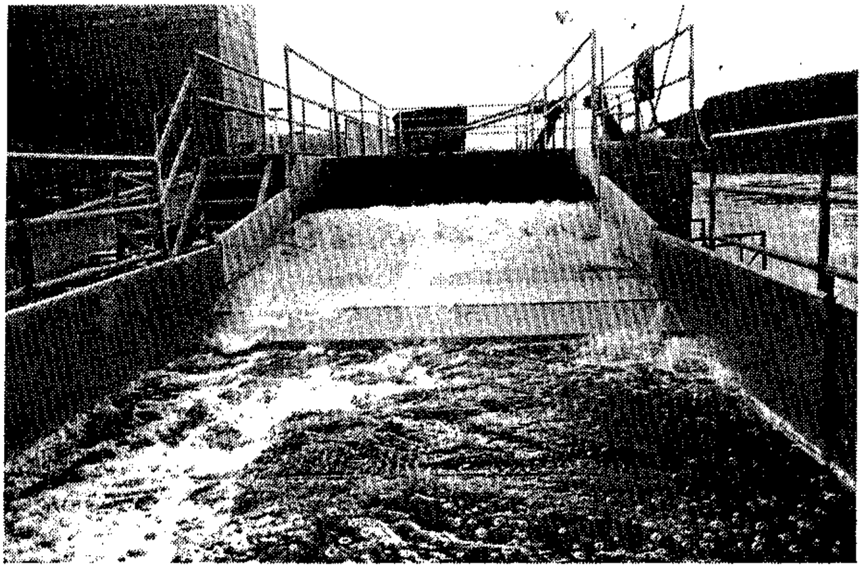


Figure 17.--A newly designed wet separator at Little Goose Dam, 1981.

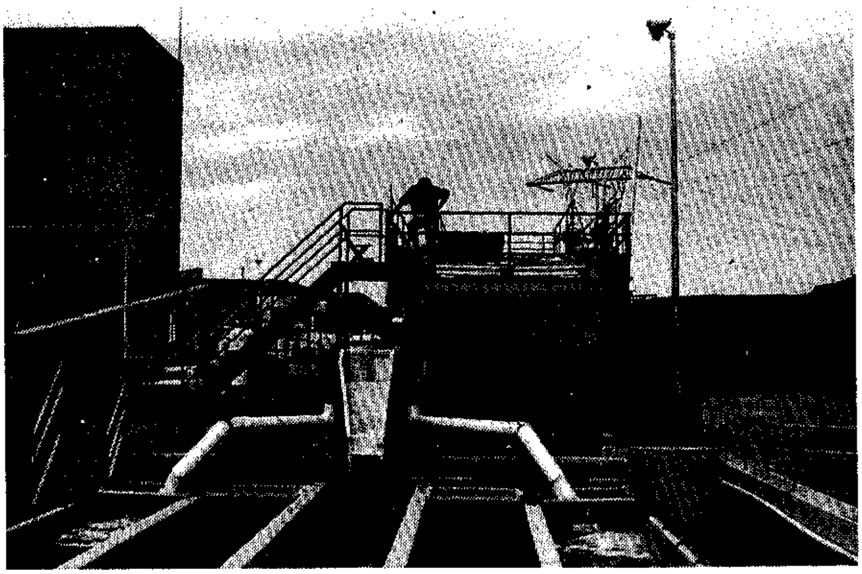


Figure 18.--Fingerling fish distribution system at Little Goose Dam.

Another change for the 1981 season was a new distribution system from the separator hopper to the raceways (Figure 18). Two open aluminum flumes (side by side) were installed prior to the season. One flume was used for small fish and the other for larger fish. Small fish were diverted to the two south raceways while the larger grade fish were shunted to the two north raceways. The distribution system was designed to sample fish from both flumes in the middle raceway.

The wet separator was difficult to test properly due to the design and problems in the system. Surging in the upwell caused continual manual adjustment of water levels at the wet separator. The surging problem was inherent in the system after the pinch valve was removed. The project will have a new bypass hopper installed in 1982 which should allow the separator to work as designed.

To minimize upwell surging, the bypass hopper level was held near a constant level approximately 4 feet below the red mark (designed operating level) in the hopper (approximately elevation 624). To achieve the desired hopper level, the make up water valve was generally set between 10% and 20% open with 20 to 28 gatewell orifices open. Exact valve setting and orifice use varied with the forebay elevation. The separator was monitored 24 hours a day so adjustments to the water supply could be made as needed.

The lower bypass hopper level setting was not considered as an ultimate solution and pressure tests in the bypass hopper and 42 inch pipe were conducted to aid in determining the cause of mortality in the bypass system. Concurrent fish release tests were planned but dropped because of warm water conditions that would adversely affect holding test fish and probably bias the results. Results of the pressure tests indicated a negative pressure zone immediately below the hopper neck that diminished with depth (6 feet to 10 feet) in the pipe to eventually become a positive pressure. The results were similar to theoretical calculations and not conclusive in providing evidence concerning causes of fish injury.

The bypass hopper will be modified before the 1982 season to provide increased depth and a smoother transition to the 42 inch pipe. This should reduce mortalities and surging at the separator.

On several occasions fish taken from the separator showed gas bubble symptoms. It was suspected that fish remaining on top of the separator bars for extended periods of time, exposed to shallow water conditions were then susceptible to elevated gas saturation levels in water emerging from the upwell. Large spills from Lower Granite Dam when it was concentrated in a few bays rather than across the spillway caused nitrogen supersaturation. Water plunging into the bypass hopper was also a potential source of supersaturated water. Little mortality was attributed to the gas bubble problem; however, the wet separator may need modification to discourage fish from accumulating near the water surface.

Trash

Debris was a problem at Little Goose just as it was elsewhere. Trash racks were raked prior to the transport season and once during the season. Gatewells were checked regularly for trash accumulations. Gatewell cleanup is one of the few areas where the project was remiss in its promptness of response.

Foam caused by turbulence in the bypass hopper, 42 inch line, and upwell limited debris separation capability. When debris blocked the separator hopper outlets to the tunnel counters, it was necessary to shut down the entire system and drain the separator to remove debris. When the separator is shut down, so is the water supply to the raceways. Also, all fish are diverted to the river at this time. It took about 15 to 20 minutes each time hoppers were cleaned. An independent water supply to the raceways will be installed prior to the 1982 season. In addition, trip gates in the bottom of the separator hopper will be installed to facilitate trash removal.

On three occasions barge loading was not completed because debris clogged the loading lines. The worst areas in the lines for clogging were by the valves and at the 90° bends. The loading line will be modified before the 1982 season to increase the size from 6 inches to 10 inches and take out the 90° bends.

Raceway debris accumulation was also severe, causing clogged outlets and clogged truck loading hopper valves. The fish crowder was used to push debris towards the downstream end of the raceway. The crowder was then retreated and the stoplogs were raised to flush the debris from the raceway. Fish tended to fight the current and not exit the raceway; however, they were subjected to crowding and related stresses. The crowder will be modified for 1982 and a second crowder panel will be provided that is open at the top and closed on the bottom 18 inches. With this, debris can be crowded to one end of a raceway while allowing fish to escape over the screen.

Fish Collection

The total number of fish collected at Little Goose in 1981 was 1,464,991, down considerably from the 1980 total of 2,282,987 (Table 2). Of these 504,311 were chinook and 880,680 were steelhead. The peak collection day for both species occurred on May 5 when 66,817 chinook and 171,817 steelhead were collected in a 24-hour period.

The majority of both species were barged (372,681 chinook, 774,668 steelhead); however, the trucking season extended over a longer period of time: from April 20 through May 7, and June 5 through July 25. Barging lasted from April 26 through June 4. From June 4 until June 14 fish were trucked from Little Goose to McNary and loaded onto a barge for transport on down the river (Table 5).

Collection was calculated for Little Goose at 18.3 percent for chinook and 22.6 percent for steelhead. This was determined by using NWAFC estimated outmigration arriving at Lower Granite of 3.2 million and 3.9 million chinook and steelhead, respectively. Total collection for the Snake River projects in 1981 is estimated at 45.6 percent for chinook and 70.2 percent for steelhead. These figures are below the 1980 estimates of 58 percent for chinook and 79.4 percent for steelhead. The major factor affecting collection in 1981 was spill during the peak migration period; no spill occurred during this period in 1980.

Descaling still plagues the Little Goose fingerling facility. Descaling was measured throughout the peak migration season, from April 20 to May 31. The average descaling rate of chinook salmon in the daily sample was 13.5% (high of 21.0% on May 28 and 30) while the 1980 descaling percentage for chinook was estimated at 11.0%. The steelhead descaling rate was calculated at 11.4% (high of 22.0% on May 23), 2.8% higher than the 1980 figure of 8.6%.

The 1981 mortality rate of juvenile fish was not considered excessive; however, there is room for improvement in 1982. Overall mortality for total fish collected during the 1981 fish season totaled .97% (chinook = 1.3%, steelhead = .75%).

Submersible Traveling Screens

Traveling screens were inspected at Little Goose with video monitoring equipment, similar to the procedure described for Lower Granite, on April 27-29, May 21 and 22, June 10 and 11, and July 17 and 18. No problems were noted on the new screens; however, the old screens (in gatewell slots 5B through 6C) did need mesh repairs during the season. After the first inspection, 3 screens had to be pulled for patching torn mesh, and 2 were pulled after the second inspection. One screen each time was pulled after the third and fourth inspections. One of the screens had to be patched after each inspection (5B). Other screen maintenance required during the season included the following:

1. Moisture probe tripped motor relay (slot 1A on May 7), back in service same day.

2. Water in motor (slot 2B on April 7), motor replaced and screen back in service April 15.

3. Breaker tripped (slot 3A on June 17), screen pulled and inspected.

4. Amp meter reading excessive load (slot 4C on April 8), repaired and back in service April 13.

5. Motor stopped (slot 6C on May 22), repaired and in service May 27.

When the traveling screens were pulled at the end of the transport season and inspected, excessive wear was noted on the drive chain tracks, sprockets, and bearings. Thought is being given to ways of reducing wear by reducing operating time.

Sampling and Loading Operations

Barge loading incorporates a gravity feed system from the raceways. The loading pipe is 6 inches in diameter, and fish encounter three 90 degree bends in the pipe enroute to the barge.

Truck loading is accomplished by transferring fish into two 4 feet by 4 feet by 4 feet hoppers that are raised over the trailer. Fish are released through a 6 inch ball valve into the trailer tanks. This method of loading is believed to cause considerably more stress on the fish than gravity loading through a pipe. On one occasion in 1981, a power cable to the electric winch motor was pulled loose and a hopper full of fish (approx. 2,000) were stranded in mid air while an electrician was summoned from the powerhouse. Before the fish could be released into the truck through a section of hand-held flex hose, oxygen stress symptoms appeared. The loading technique presented safety problems for personnel loading the trucks. Fishery agencies have unanimously recommended that a gravity loading system be installed at Little Goose.

A small percentage of the fish were diverted hourly into a sample raceway and held. Each day they were moved into the handling building via the truck loading hopper. Fish were routinely checked for general condition (descaling), weight (fish per pound), and species composition. No fish marking operations occurred at Little Goose in 1981.

A fish pump test was conducted at Little Goose on April 22 to examine an alternate method of loading fish into transport trucks. An Aqua-Life Pump, built by Magic Valley Heli-Arc & Mfg. of Twin Falls, Idaho, was tested and the results were negative. One hundred chinook and 200 steelhead were tested but only 18 and 31 percent respectively were actually pumped. Of the chinook, 22 percent were in good condition, 39 percent were partially (up to 5%) descaled, and 39 percent died. For steelhead the numbers were 42 percent in good condition, 29 percent partially descaled, 3 percent severely (10% or greater) descaled, and 26 percent were mortalities. The results suggest that this system is not feasible at the project.

TRANSPORT OPERATIONS - MCNARY

Collection of Juveniles

Prior to the transport season, the NPW and fishery agencies agreed to complete screening of McNary in 1981 and transport of all juvenile smolts collected. In 1981 the fingerling collection system began operating on March 27 and continued uninterrupted through September 11. Four shipments of screens arrived on the following dates: January 29, February 19, April 9, and May 14. After the screens were received, they were tested for 48 hours, and accepted or rejected by the Corps. Three screens from the last shipment were rejected so gatewell slots 13B, 13C, and 14A were unscreened throughout the season. Thirty nine of the forty two turbine gatewell intakes were screened by May 29, and were pulled from service by October 29. Only six intakes were screened in 1980. Fish collection more than doubled any previous transport season.

The following modifications were added to the collection system in 1981:

1. Three screens (1978 vintage) were modified to meet standards and criteria for gap and throat opening. All other screens were new.

2. The bypass gallery screens were modified by adding a 10 inch extension to the screen slot area of the bypass flume to reduce impingement of fish.

3. The hopper section of the fingerling separator was modified by project personnel to incorporate seven electronic counting tunnels in 1981 as compared to only four in 1980.

4. The new fish distribution system was an aluminum flume-type design with the following dimensions: 28 inches wide x 18 inches high. The system delivered fish to the raceways via a 24 inch gate opening (Figure 19).

5. Two new portable type raceways were built on the tailrace deck to increase the holding capacity of the McNary facility during the spring barge season (Figure 20).

An early release of spring chinook from Ringold Hatchery prompted the McNary project to begin fingerling collection prior to the anticipated April 1 start-up date. The first truckload of fish left on March 30, and the last on September 11. The first and last bargeloads of fingerlings departed the facility on April 24 and June 14, respectively.

The time periods when the various species migrated through the project were:

Steelhead	- March 27 through July 17
Spr/Sum Chinook	- March 27 through July 7
Fall Chinook	- May 13 through September 11
Coho	- May 4 through July 10
Sockeye	- March 27 through August 3

Fingerlings were counted via electronic fish counters as they exited from the separator hopper and into the distribution flume. Over 4 million juveniles were counted into the collection facilities during the transport season (Appendix Table 3). A total of 2,439,559 were trucked and 1,673,434 were barged (Table 1). Fish marked for truck and barge experiments are summarized in Appendix Table 4.

Fish numbers remained high throughout the spring migration period. The high count during the spring migration season was 153,911 on May 11 as compared to a high count of 68,768 on May 7, 1980. The fall chinook migration peaked earlier in 1981 than in previous transport seasons. The peak collection day for fall chinook was 174,060 on June 30, as compared to 52,346 on July 6, 1980.

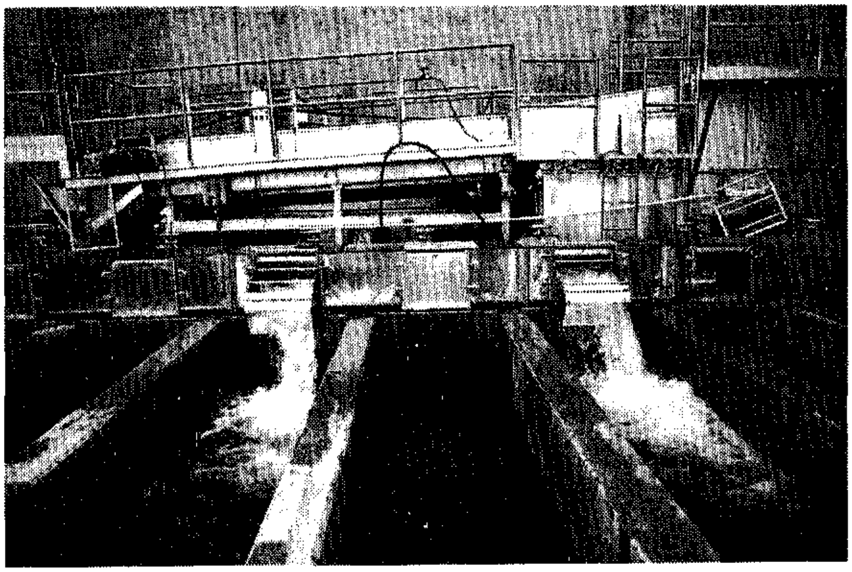


Figure 19.--Fingerling fish distribution system at McNary Dam.

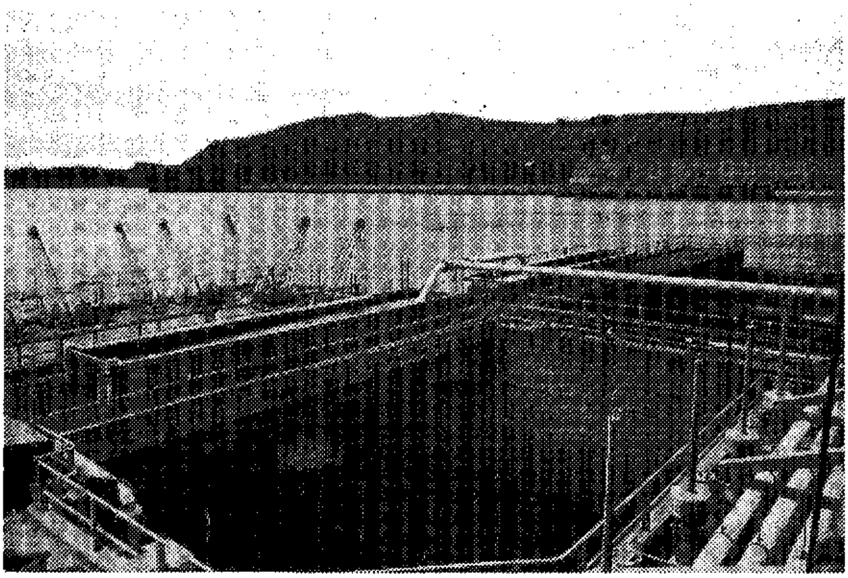


Figure 20.--New temporary raceways placed into service at McNary Dam, 1981.

The relative abundance of fish arriving at the dam is unknown. There were no indexing studies or population estimates available to determine the collection efficiency at McNary in 1981.

The 1981 season had river flows which produced large spills at McNary Dam. From May 26 through June 30 there was a daily spill of 10 to 71 percent of the daily average flow. Factors which affect juvenile collection are volume of spill and the time period when the spill occurs. In many cases the spills occurred when large numbers of fish were moving through the system, i.e., just prior to sunset when power demands decreased. A large portion of the fish were probably not collected during periods of high spill.

Facility and O&M

Prior to the juvenile outmigration season, the forebay area was cleared of debris, mostly wood products, and gatewells were inspected for debris accumulation. Throughout the fish migration period, the facilities were inspected and cleaned as necessary to prevent debris buildup from hampering fish passage.

Trash racks at the project were difficult to rake due to inadequate equipment. Debris is compacted or "stomped" from the upper level of the racks to the bottom of the racks. This action produced only limited success in reducing gatewell drawdown. The equipment was removed mid-way through the migration season for modifications. Gatewell drawdown criteria were exceeded in several units during the season. Drawdown criterion is a maximum of 1.5 foot differential measured between the forebay water level and the gatewell water level. Drawdown is greater as the turbine unit capacity is increased.

The two new raceways were available for use during the barge season only and were not adapted for loading trucks. Each raceway has a single pass, flow through water system with a maximum volume of 7644 gallons of water and a carrying capacity of 3822 lb of fish per container calculated at 0.5 lb. of fish per gallon of water. The raceways were used infrequently during the spring collection season.

Problems with screen operation occurred early in the transport season. Moisture leaked into the electrical couplings causing the circuit breakers to trip. This problem was remedied by wrapping the couplings with a plastic covering. New moisture-proof couplers, to be installed before the 1982 season, should eliminate this problem. Ampere meter readings were checked daily to insure that screens were operating. When ampere readings varied significantly, the project operator and/or project fish biologists initiated corrective action to restart the screen.

There were 3 days during the season when screen failures resulted in out of service time.

1. April 9 - Moisture probes tripped the electrical breakers on 10 screens. They were out of service for four hours.

2. May 25 - Moisture probes tripped the electrical breakers on 10 screens. They were out of service for 8½ hours.

3. June 6 - Moisture probes tripped the electrical breakers on 10 screens. They were out of service for 2 hours.

One screen in gatewell slot 1B was out of service from June 19 through June 29 with a motor failure.

Video TV inspections, using a monorail frame that allows the camera to traverse across the screen and view each panel section, were accomplished with no turbine unit outages. The inspections were conducted on June 16 and July 28 with only 3 of the 14 units inspected. Even though the majority of the screens were new, the frequency and extent of video inspections were inadequate. If STS's were damaged, they would not have been discovered and repaired.

A final, year end inspection showed the new screen mesh to be in excellent condition. The three old screens had significant damage to the mesh, plus the drive chain, sprocket, and bearings were worn out and in need of replacement. New STS's also had signs of sprocket wear.

Debris

Although the forebay and gatewells did not have large debris accumulations, debris was a problem in the bypass gallery (flume screens). There were many days when the bypass flume screens were necessarily cleaned several times per shift. Materials which caused most of the problem included filamentous algae, aquatic and terrestrial vegetation (e.g., Potamogeton Sp., and tumbleweed) and wood chips. Late in the season, accumulation of adult shad scales was a serious problem.

Debris was also a problem in the four inch counting tunnels from the hopper/separator to the raceways. The tunnels were checked several times daily to assure that no obstructions were blocking the fishes' exit from the hoppers. They were blocked on numerous occasions. On 92 of the 169 days of the transport season, there was a minimum of one tunnel partially or completely plugged with debris at some time during the day. A new wet separator design with two larger hopper outlets (6 inch by 12 inches) will alleviate the problem of debris plugging in the separator hopper pipes in 1982.

Descaling

During the 1981 spring migration season, examination of fish for descaling was sporadic. Only in May were any fish sampled specifically for descaling. This sampling period coincides with the normal highest descaling period so ranges for the total spring season would be less than indicated below. Ranges of descaling are listed for the 8 sampling days in May:

spring chinook	-	13.6 to 52.7 percent
steelhead	-	2.6 to 17.1 percent
coho	-	8.3 to 25.9 percent
sockeye	-	5.7 to 31.4 percent

Fall chinook were sampled more extensively for descaling than were the spring migrants. Fall chinook had a descaling range of from 0.4 to 25.0%. Average descaling for the months of July and August were 2.4% and 8.7%

respectively. Sample size for the fall chinook totaled 4433 fish, of which 189 were descaled for a seasonal average of 4.3%.

Facility Fish Mortalities

Fish mortalities were slightly higher in 1981 than 1980, 1.4% vs. 1.3% respectively. Mortality totals by species for the season are: fall chinook, 1.9%, steelhead, 0.7%, spring chinook, 0.9%, sockeye, 0.6%, and coho, 0.3%. Daily mortality totals for combined species are found in Appendix Table 3.

Fall chinook juveniles suffered high mortality rates (in excess of 3%) during the month of August. The sudden increase in fall chinook mortality raised concern that there was some new problem. Several physiologists looked at the fish, but could find no evidence of physical damage, disease or toxic substance problem. No specific conclusion as to where the problem was located could be made. Dr. Gerald Bouck, from the U. S. Fish and Wildlife Service, National Fisheries Research Center, Seattle, assumed the mortality occurred in the collection process subsequent to the fishes' arrival into the gallery bypass flume. He based this assumption upon examination of moribund fish in the bypass flume.

A number of fish autopsied displayed no outward symptom of injury and had been feeding actively, as their stomachs were full of food. Dr. Bouck felt the mortalities may have been induced by something traumatic such as an electric shock from the screens or another electrical source (whereby the fish would suffer a "heart failure" and die). (This view is only an assumption).

Another explanation for the high fall chinook mortality rate was the presence of large numbers of adult shad near the north end of the bypass flume during the last week of July and through mid-August. The shad caused two major problems. First, the large deciduous shad scales plugged the bypass screens creating higher water velocities through the screens. Second, the large shad numbers provided a barrier which the fall chinook fingerlings seemed reluctant to move through. The barrier was probably more psychological than physical. Water temperatures were 67°-69°F., so a delay in migrating through the bypass flume could cause fatigue and eventual mortalities if they are delayed beyond their swimming ability. Any delay beyond their swimming ability would result in an increase in stress related mortality.

Several methods were tried to alleviate the adult shad problem. They included: 1) placing salt concentrations in bypass flume, 2) removing weir boards to flush the adults from the flume, and 3) using an electro shocker. The first two methods were unsuccessful. With the shocker set on low amperage and the electrodes placed at least 10 feet apart, shad were effectively removed from the flume. This method is viewed only as a temporary solution, and if the problem recurs, a more satisfactory solution will have to be developed.

Marked Releases

Various groups of fish are marked each season for research or evaluation purposes. The NWAFC research staff handled fish for two separate studies during the juvenile migration season.

Marked fish for transport evaluation received adipose clips, distinctive freeze brands, and coded wire tags. All marked groups were obtained from a raceway containing a random sample of the total population of fish arriving during a 24-hour period. The transport evaluation release during the month of July totaled 85,504 marked fall chinook. Of this group, one-half were transported by truck below Bonneville Dam, and one-half were released in the McNary tailrace as controls. Adult returns from these marked groups will add to the data base established from previous transport experiments conducted from 1978 to 1980.

A John Day Dam study had a spring release of 41,285 fingerlings which were freeze branded only. This marked group consisted of 15,223 steelhead, 19,491 spring chinook, 1415 coho, and 5,156 sockeye. An additional 17,723 fall chinook were marked in June and 16,779 in August with a brand plus a coded wire tag as part of the same study.

Loading and Densities

At no time during the transport season was the raceway holding or loading capacity exceeded at McNary. Loading techniques were similar to previous seasons with fish crowded to the west end of a raceway for truck loading, and to the east end of a raceway for barge loading. The barge loading operation incorporates a gravity feed system which minimizes the need for crowding raceways.

Loading fish from raceways to the transport vehicle has been a source of criticism at collector dams. Attempts to reduce stress or loading injuries has always been a goal. Because loading to the trucks at McNary has been cumbersome, especially for fall chinook, a new flume type design will be implemented in FY 82 for loading trucks. It is expected that the new system will not only speed up the loading process, but also reduce stress.

Transport of Juveniles

McNary Dam has principally used trucks as the major transport vehicle. Trucked fish account for 59.3% of the total transported for the season. This figure may be misleading because the majority of the spring fingerling outmigration is barged. Fall chinook comprise the summer migrants of the Columbia River system, a time period when the barges were not operating. In 1981, a total of 2,031,925 were trucked; 96.5 percent of the total fall chinook transported.

Loading and transporting fish by barge went very smoothly in 1981. Fish from the McNary raceways were generally placed into a separate compartment from the Snake River fish. In some instances, fish were mixed with the upriver loads. A breakdown by percentage barged of each specie is: spring chinook, 57%; steelhead, 17%; sockeye, 17%; coho, 5%; and fall chinook, 4%.

Driving time from the project to the release site at Bonneville Dam takes approximately 3½ to 4 hours. A fish barge from McNary requires about 19 hours to reach the dump site downstream of Bonneville Dam.

Truck operations had one minor setback in 1981. A load of fish on August 7 was prematurely dumped at Hood River, Oregon, in the Bonneville pool due to increasing water temperature and fish mortalities in the fish tanker. The fuel line to the refrigeration unit malfunctioned, and the water in the tank rose to 72° F. There was a 5° F rise in water temperature from McNary to the release point. The load contained 23,267 fall chinook and suffered a mortality of approximately 160 fish or a 0.7% mortality for the load. Trucking otherwise was very efficient this season with few mechanical failures or equipment breakdowns.

Seasonal truck mortality, as estimated by the drivers, totaled 5611 fish in 124 truck loads. Average mortality per truckload was 0.23% with a range of 0.06% to 0.87%. No attempts were made to tally mortalities by species on any truck loads. Mortalities are an estimate of the mixed total of fish in the truck based on visual observation rather than a total count. The observations are often made in poor light and represent the truck driver's best estimate. Total estimated mortality from April 6 to May 27 was 2055 of the 330,643 fish hauled; a 0.62% mortality rate.

RECOMMENDATIONS FOR PROJECT MODIFICATIONS - 1982

Fishery agencies and NPW personnel met throughout the season to discuss methods of improving the transport process. Recommendations were compiled and submitted to the Columbia River Fisheries Council for transmittal to the Division Engineer, North Pacific Division, Corps of Engineers, Portland on July 19, 1981. Recommendations are listed by project:

Lower Granite, Little Goose, and McNary Dams

1. Modification of the separator for wet separation of unwanted fish (adult chinook salmon, steelhead kelts, scrap fish) and debris.

2. Modification of the separator hopper outlets and distribution system to meet the following criteria:

a. ability to automatically subsample a portion of the fish for counting and holding.

b. better debris handling.

c. capability to divert fish directly to sample tanks, raceways, or barges.

3. Purchase of a video monitoring system that will allow inspection of traveling screens and other parts of the collection system without unwatering.

4. Increased size of barge loading line from six inch to ten inch.

Lower Granite Dam

1. A log/trash boom in the forebay to be operable by April 1, 1982.

Little Goose Dam

1. Improved hopper system for delivering fish from the collection gallery to the separator upwell by deepening the hopper and making a smoother transition at connection with 42 inch line.

2. Realignment of barge loading pipe to eliminate 90 degree angle turns in the pipe. Also, a boom for handling the loading hose is needed.

3. Modification of the raceway water supply by adding a line to supply water directly to the raceway headbox independent of separator operation. Add gate valve controls to replace the stoplog control for water from the headbox to individual raceways.

McNary Dam

1. Modification of raceway water supply, as described for Little Goose Dam, to be independent of separator operation.

2. Modification of plumbing from raceways through the barge loading conduit to allow for inspection and debris removal.

3. Trash rake to be operable by the juvenile fish run.

4. Modification of barge loading raceways to include sloping the system to the release pipe to reduce crowding.

1982 MAJOR PROJECT MODIFICATIONS

All of the recommended modifications sent to NPD, with the exception of the McNary Dam trash crane, will be placed into operation at the NPW projects. Two of the modifications, the Little Goose wet separator and the barge loading raceways at McNary, were changed slightly from the original designs to incorporate agreed-upon changes.

Additional modifications are under construction or have been adopted by the NPW. They are by site:

Little Goose Dam

1. Improved safety features for truck loading hoppers and larger release gate valves.

2. Removal of pinch valve.

McNary Dam

1. Modification of truck loading system to a flume-type design rather than the current 6 inch outlet pipes.

2. Purchase of a self-propelled and self-cleaning rotary drum screen for testing in the bypass flume. If successful, more screens will be purchased later when funds are available.

Transport Vehicles

1. The NPW is presently reskinning one trailer and adding agitators to it. If the agitator system works in 1982, the other 4 trailers will likely be modified.

2. A fourth fish barge being constructed by the Nichols Boat Company of Hood River, Oregon will be completed by April 1, 1982. The NPW will have the fish barge on line for the upcoming fish transport season.

Submersible Traveling Screens

1. A contract is presently out to modify traveling screens at Granite and Goose plus 3 at McNary. These will also get new mesh. Projects are submitting to NPW plans for on/off operation of STS's to coincide with unit operation. Research will be conducted in 1982 to evaluate the feasibility of a cyclic operation of the screens. If feasible, this operational change will most likely be made prior to the 1983 outmigration season.

Acknowledgements

We thank state, federal and NPW fishery biologists involved in the transportation program for their cooperation and assistance in making "Operation Fish Run" a successful program and a smooth transition to a management operation. We thank R. Z. Smith, NMFS, Portland, Oregon, for his valuable help and comments on graphics and computer operations. Special thanks to Alma Follis for her fine job of typing this publication.

LITERATURE CITED

MATTHEWS, G. M., G. A. SWAN, and J. R. SMITH.
1977. Improved bypass and collection system for protection of juvenile salmon and steelhead trout at Lower Granite Dam. Mar. Fish. Rev. 39(2):10-14.

RAYMOND, H. L.
1979. Effects of dams and impoundments on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975. Trans. Am. Fish Soc.,: 108 (6):505-529.

APPENDIX TABLES 1 - 4

APPENDIX TABLE 1 - Daily counts of steelhead and chinook salmon, facility mortalities, and daily river flows and spills at Lower Granite Dam, 1981.

	Daily Collection			Collection Mortality				Daily Average	Spill	
				Steelhead		Chinook		River Flow		
	Steelhead	Chinook	Daily Total	#'s	%	#'s	%	in CFS	Total	%
Apr. 3	300	902	1,202	-	-	22	2.44	41,500		
Apr. 4	288	897	1,185	1	0.35	13	1.45	42,700		
Apr. 5	288	897	1,185	1	0.35	13	1.45	35,100		
Apr. 6	288	897	1,185	2	0.69	13	1.45	32,200		
Apr. 7	371	1,660	2,031	-	-	23	1.38	38,200		
Apr. 8	272	1,562	1,834	-	-	14	0.90	32,300		
Apr. 9	389	3,851	4,240	-	-	18	0.47	32,700		
Apr 10	324	3,279	3,603	-	-	12	0.37	31,400		
Apr 11	100	1,715	1,815	1	1.00	2	0.12	30,500		
Apr 12	238	4,245	4,483	1	0.42	2	0.05	31,400		
Apr 13	245	5,289	5,534	1	0.41	27	0.51	29,200		
Apr 14	155	4,536	4,691	1	0.64	19	0.42	29,800		
Apr 15	170	3,446	3,616	-	-	8	0.23	27,800		
Apr 16	260	3,802	4,062	-	-	7	0.18	29,500		
Apr 17	184	4,406	4,590	-	-	2	0.04	30,800		
Apr 18	120	2,545	2,665	-	-	9	0.35	35,600		
Apr 19	156	6,340	6,496	-	-	11	0.17	36,200		
Apr 20	490	19,898	20,388	-	-	35	0.18	43,300		
Apr 21	653	27,733	28,386	-	-	41	0.15	52,200		
Apr 22	878	32,839	33,717	-	-	108	0.33	60,100		
Apr 23	1,874	34,156	36,030	1	0.05	109	0.32	64,800		
Apr 24	3,661	39,923	43,584	3	0.02	98	0.24	75,700		
Apr 25	12,692	49,219	61,911	8	0.06	245	0.50	86,800		
Apr 26	33,703	57,881	91,584	7	0.02	167	0.29	87,000		
Apr 27	45,188	77,605	122,793	37	0.08	511	0.66	89,400	5,300	6
Apr 28	48,557	43,582	92,139	14	0.03	191	0.44	96,900	10,000	10
Apr 29	38,266	34,761	73,027	15	0.04	356	1.02	92,300	5,800	6
Apr 30	40,907	25,178	66,085	6	0.01	101	0.40	98,300	13,200	13

APPENDIX TABLE 1 - Continued

	Daily Collection			Collection Mortality				Daily Average	Spill	
	Steelhead	Chinook	Daily Total	Steelhead #'s	Steelhead %	Chinook #'s	Chinook %	River Flow in CFS	Total	%
May 1	41,772	14,601	56,373	20	0.05	140	0.96	109,600	29,700	26
May 2	56,140	19,521	75,661	12	0.02	110	0.56	130,500	38,900	31
May 3	189,212	65,791	255,003	28	0.01	1,535	2.33	130,800	41,700	32
May 4	60,014	18,643	78,657	14	0.02	100	0.02	119,200	36,400	29
May 5	38,426	8,766	47,192	10	0.03	135	1.54	103,200	17,200	17
May 6	40,734	6,198	46,932	4	0.01	15	0.24	90,300		
May 7	51,619	4,570	56,189	3	0.01	27	0.59	83,600		
May 8	72,413	3,419	75,832	20	0.03	28	0.82	75,100		
May 9	74,678	2,956	77,634	15	0.02	5	0.17	71,100		
May 10	83,448	4,867	88,315	5	0.01	15	0.31	66,000		
May 11	61,716	3,600	65,316	12	0.02	72	2.00	66,700		
May 12	60,465	4,315	64,780	13	0.02	21	0.49	64,900		
May 13	39,495	5,455	44,950	14	0.03	54	0.99	64,400		
May 14	25,232	4,563	29,795	12	0.05	24	0.53	61,400		
May 15	28,754	3,298	32,052	6	0.02	10	0.30	61,800		
May 16	27,826	7,123	34,949	25	0.09	41	0.58	62,200		
May 17	22,412	5,408	27,820	16	0.07	39	0.72	62,300		
May 18	23,196	5,597	28,793	9	0.04	27	0.48	53,000		
May 19	22,247	3,782	26,029	16	0.07	9	0.24	51,700		
May 20	16,659	3,745	20,404	9	0.05	9	0.24	51,700		
May 21	12,643	3,706	16,349	9	0.07	18	0.49	68,300		
May 22	26,238	7,868	34,106	18	0.07	18	0.23	103,300	4,300	4
May 23	90,667	13,731	104,398	64	0.07	121	0.88	107,600		
May 24	70,852	10,730	81,582	130	0.18	152	1.42	106,400		
May 25	65,218	9,199	74,417	15	0.02	33	0.36	107,900		
May 26	51,198	9,435	60,633	141	0.27	95	1.01	120,800	10,800	9
May 27	41,790	7,671	49,461	13	0.03	24	0.31	131,000	21,300	16
May 28	33,249	10,821	44,070	23	0.07	34	0.31	130,000	19,800	15
May 29	30,941	5,753	36,694	30	0.10	20	0.35	127,200	18,700	15
May 30	18,751	4,489	23,240	30	0.16	35	0.78	126,300	19,500	15
May 31	19,150	3,355	22,505	10	0.05	15	0.45	127,400	16,000	13

APPENDIX TABLE 1 - Continued

	Daily Collection			Collection Mortality				Daily Average		
				Steelhead		Chinook		River Flow	Spill	
	Steelhead	Chinook	Daily Total	#'s	%	#'s	%	in CFS	Total	%
Jun. 1	16,929	2,969	19,898	37	0.22	15	0.50	134,500	39,100	28
Jun. 2 *	18,065	4,911	22,976	16	0.09	16	0.33	122,400	15,800	13
Jun. 3	12,172	10,352	22,524	20	0.16	25	0.24	123,000	14,100	12
Jun. 4	12,883	3,989	16,872	19	0.15	17	0.43	124,300	15,600	13
Jun. 5	12,720	3,483	16,203	19	0.15	18	0.52	114,000	7,600	7
Jun. 6	21,735	3,262	24,997	33	0.15	19	0.58	121,300	43,100	38
Jun. 7	2,764	3,070	5,834	20	0.72	13	0.42	138,900	70,700	51
Jun. 8	6,197	6,884	13,081	20	0.32	13	0.19	140,200	67,400	47
Jun. 9	5,251	2,985	8,236	10	0.19	10	0.33	172,900	103,300	59
Jun 10	3,631	2,064	5,695	10	0.27	10	0.48	176,100	101,200	56
Jun 11	5,514	2,188	7,702	15	0.27	10	0.46	157,600	66,900	27
Jun 12	5,005	1,986	6,991	15	0.30	10	0.50	146,800	54,400	38
Jun 13	5,870	795	6,665	10	0.17	10	1.26	150,900	92,100	60
Jun 14	3,599	477	4,076	11	0.31	1	0.21	142,900	71,000	50
Jun 15	3,836	509	4,345	10	0.26	-	-	134,000	51,200	38
Jun 16	2,985	1,059	4,044	5	0.17	5	0.47	124,200	35,700	29
Jun 17	2,439	2,052	4,491	5	0.20	10	0.49	133,100	23,400	18
Jun 18	3,163	2,661	5,824	10	0.32	15	0.56	121,200	10,000	8
Jun 19	4,251	5,310	9,561	16	0.38	32	0.60	120,300	11,000	9
Jun 20	2,753	3,440	6,193	8	0.29	33	0.96	127,600	46,500	36
Jun 21	1,228	1,007	2,235	10	0.81	25	2.48	117,800	36,100	31
Jun 22	3,518	2,883	6,401	40	1.14	40	1.39	106,800	12,800	12
Jun 23	2,829	2,291	5,120	5	0.18	5	0.22	102,000	3,300	3
Jun 24	2,150	1,741	3,891	5	0.23	5	0.29	97,700	5,000	5
Jun 25	2,513	1,577	4,090	10	0.40	10	0.63	84,800		
Jun 26	1,603	1,006	2,609	14	0.87	34	3.38	78,200		
Jun 27	693	1,371	2,064	10	1.44	10	0.73	73,000		
Jun 28	947	1,865	2,812	5	0.53	15	0.80	65,800		
Jun 29	606	1,199	1,805	10	1.65	10	0.83	63,200		
Jun 30	1,106	2,190	3,296	11	0.99	14	0.64	60,700		

APPENDIX TABLE 1 - Continued

	Daily Collection			Collection Mortality				Daily Average	Spill	
	Steelhead	Chinook	Daily Total	Steelhead		Chinook		River Flow		
				#'s	%	#'s	%	in CFS	Total	%
Jul. 1	410	2,563	2,973	10	2.44	10	0.39	51,900		
Jul. 2	523	3,268	3,791	10	1.91	15	0.46	51,300		
Jul. 3	320	2,880	3,200	5	1.56	15	0.52	49,400		
Jul. 4	264	2,363	2,627	5	1.89	20	0.85	46,600		
Jul. 5	145	1,702	1,847	5	3.45	25	1.47	43,900		
Jul. 6	203	2,378	2,581	5	2.46	50	2.10	43,300		
Jul. 7	133	2,710	2,843	2	1.50	30	1.11	47,800		
Jul. 8	138	2,825	2,963	2	1.45	110	3.89	54,800		
Jul. 9	196	3,970	4,166	5	2.55	73	1.84	46,500		
Jul 10	77	1,568	1,645	5	6.49	72	4.59	40,500		
Jul 11	18	1,655	1,673	2	11.11	55	3.32	38,300		
Jul 12	16	1,495	1,511	2	12.50	42	2.81	35,100		
Jul 13	20	1,108	1,128	2	10.00	30	2.71	34,100		
Jul 14	21	1,233	1,254	5	23.81	60	4.87	36,500		
Jul 15	183	1,317	1,500	2	1.09	21	1.59	31,000		
Jul 16	140	1,010	1,150	2	1.43	21	2.08	33,300		
Jul 17	190	1,176	1,366	5	2.63	31	2.64	33,700		
Jul 18	205	1,267	1,472	2	0.98	15	1.18	37,600		
Jul 19	94	1,293	1,387	2	2.13	25	1.93	29,400		
Jul 20	72	988	1,060	13	18.05	24	2.43	29,000		
Jul 21	77	970	1,047	4	5.19	35	3.61	32,800		
Jul 22	95	1,171	1,266	5	5.26	40	3.42	29,300		
Jul 23	57	1,297	1,354	5	8.77	55	4.24	29,400		
Jul 24	32	753	785	7	21.87	58	7.70	28,600		
Jul 25	40	535	575	3	7.50	25	4.67	23,300		
Jul 26	41	542	583	9	21.95	38	7.01	23,100		
Jul 27	66	457	523	11	16.67	41	8.89	24,200		
Jul 28	145	1,002	1,147	20	13.79	79	7.88	21,400		
Jul 29	71	590	661	7	9.86	33	5.59	22,200		
Jul 30	54	499	553	4	7.41	31	6.21	21,800		
TOTAL	1,901,173	904,181 /A	2,805,354	1,438	0.08	6,827	0.75			

* Sockeye = 6,529 counted for season
Coho = 602 counted for season
/A Fall chinook = 60,134 are not included in the total

APPENDIX TABLE 2 - Daily counts of steelhead and chinook salmon, facility mortalities, and daily river flows and spills at Little Goose Dam, 1981.

	Daily Collection			Collection Mortality				Daily Average	Spill	
				Steelhead		Chinook		River Flow		
	Steelhead	Chinook	Daily Total	#'s	%	#'s	%	in CFS	Total	%
Apr 10	50	150	200	*		*		33,000		
Apr 11	8	26	34					31,600		
Apr 12	16	48	64					23,600		
Apr 13	15	46	61					34,700		
Apr 14								30,100		
Apr 15								29,300		
Apr 16	62	185	247					28,100		
Apr 17	52	154	206					30,700		
Apr 18	27	78	105					33,600		
Apr 19	37	110	147					36,700		
Apr 20	160	393	553					42,300		
Apr 21								52,400		
Apr 22								59,600		
Apr 23	1,582	4,745	6,327					66,400		
Apr 24	709	22,910	23,619	46	6.49	389	1.70	74,200		
Apr 25	527	15,741	16,268	4	0.76	110	0.70	86,500		
Apr 26	988	23,720	24,708	7	0.71	166	0.70	85,900		
Apr 27	1,282	29,803	31,085	4	0.31	89	0.30	89,900		
Apr 28	2,718	26,819	29,537	3	0.11	32	0.12	95,600		
Apr 29	16,206	49,076	65,282	44	0.27	147	0.30	90,800		
Apr 30	32,348	31,080	63,428	142	0.44	137	0.44	98,500		

APPENDIX TABLE 2 - Continued

	Daily Collection			Collection Mortality				Daily Average	Spill	
	Steelhead	Chinook	Daily Total	Steelhead #'s	%	Chinook #'s	%	River Flow in CFS	Total	%
May 1	18,794	29,720	48,514	88	0.47	140	0.47	111,900		
May 2	15,080	25,420	40,500	71	0.47	119	0.47	122,200		
May 3	26,928	28,934	55,862	135	0.50	145	0.50	125,100		
May 4	63,489	15,085	78,574	317	0.50	75	0.50	120,500		
May 5	171,817	66,817	238,634	1,375	0.80	535	0.80	103,300		
May 6	58,087	7,921	66,008	639	1.10	87	1.10	89,300		
May 7	23,006	6,116	29,122	414	1.80	98	1.60	84,500		
May 8	9,590	2,549	12,139	86	0.90	8	0.31	74,700		
May 9	13,959	1,066	15,025	14	0.10	2	0.19	69,700		
May 10	16,434	1,256	17,690	74	0.45	6	0.48	66,500		
May 11	14,654	3,528	18,182	66	0.45	16	0.45	71,600		
May 12	15,060	1,168	16,228	108	0.72	8	0.68	61,600		
May 13	12,501	1,389	13,890	60	0.48	7	0.50	69,500		
May 14	13,756	941	14,697	58	0.42	4	0.42	59,200		
May 15	10,945	978	11,923	109	1.00	10	1.02	63,500		
May 16	10,728	958	11,686	43	0.40	10	1.04	64,200		
May 17	12,528	2,386	14,914	50	0.40	10	0.42	63,000		
May 18	15,814	1,954	17,768	27	0.17	18	0.92	52,900		
May 19	12,606	2,473	15,079	44	0.35	9	0.36	51,500		
May 20	13,161	2,582	15,743	81	0.61	17	0.66	50,300		
May 21	13,616	4,735	18,351	47	0.34	21	0.44	67,800		
May 22	8,876	3,086	11,962	63	0.71	43	1.39	101,900		
May 23	12,181	2,389	14,570	129	1.06	69	2.89	111,300		
May 24	12,239	4,642	16,881	99	0.81	68	1.46	107,600		
May 25	22,269	8,446	30,715	91	0.41	40	0.47	105,400		
May 26	22,836	7,211	30,047	226	0.99	70	0.97	120,600		
May 27	36,830	11,951	48,781	225	0.61	210	1.76	128,900	2,500	2
May 28	26,265	8,113	34,378	311	1.18	148	1.82	127,400		
May 29	13,799	3,029	16,828	36	0.26	80	2.64	125,900		
May 30	20,285	7,889	28,174	45	0.22	50	0.63	127,400		
May 31	9,153	3,559	12,712	63	0.69	58	1.63	124,500		

APPENDIX TABLE 2 - Continued

	Daily Collection			Collection Mortality				Daily Average	Spill	
				Steelhead		Chinook		River Flow		
	Steelhead	Chinook	Daily Total	#'s	%	#'s	%	in CFS	Total	%
Jun 1	6,724	3,495	10,219	88	1.31	80	2.29	137,300	4,700	3
Jun 2	6,107	4,174	10,281	27	0.44	264	6.32	124,800	2,800	2
Jun 3	6,353	4,395	10,748	27	0.42	43	0.98	120,000		
Jun 4	7,727	3,750	11,477	46	0.59	71	1.89	122,600		
Jun 5	4,854	2,242	7,096	16	0.33	69	3.08	112,000	1,500	1
Jun 6	4,635	4,635	9,270	23	0.50	37	0.80	115,000	30,700	27
Jun 7	2,658	2,658	5,316	9	0.34	8	0.30	135,950	36,200	27
Jun 8	5,394	5,503	10,897	185	3.43	140	2.54	139,000	32,300	23
Jun 9	5,811	5,929	11,740	88	1.51	157	2.65	171,600	73,300	43
Jun 10	4,182	3,678	7,860	131	3.13	248	6.74	174,800	88,500	51
Jun 11	6,019	3,612	9,631	40	0.66	74	2.05	156,800	52,900	34
Jun 12	6,652	7,903	14,555	96	1.44	280	3.54	139,100	37,400	27
Jun 13	2,443	2,902	5,345	6	0.25	28	0.96	152,400	67,800	45
Jun 14	2,766	1,437	4,203	29	1.05	112	7.79	141,000	58,000	41
Jun 15	3,276	1,702	4,978	30	0.92	70	4.11	135,000	27,300	20
Jun 16	3,352	5,538	8,890	93	2.77	93	1.68	118,500	4,000	3
Jun 17	1,388	2,293	3,681	12	0.86	105	4.58	129,800		
Jun 18	2,383	2,173	4,556	52	2.18	161	7.41	117,900		
Jun 19	2,683	2,941	5,624	25	0.93	228	7.75	118,800		
Jun 20	981	3,283	4,264	14	1.43	448	13.65	128,200		
Jun 21	1,540	3,086	4,626	4	0.26	48	1.55	114,700	9,100	7
Jun 22	1,505	3,382	4,887	27	1.79	363	10.73	106,500		
Jun 23	1,153	2,590	3,743	29	2.51	177	6.83	106,300		
Jun 24	1,379	5,284	6,663	13	0.94	95	1.80	93,400		
Jun 25	673	2,579	3,252	7	1.04	59	2.29	85,900		
Jun 26	717	2,389	3,106	50	6.97	60	2.51	80,400		
Jun 27	350	1,164	1,514	2	0.57	12	1.03	71,200		
Jun 28	68	1,081	1,149	6	8.82	27	2.50	61,200		
Jun 29	60	959	1,019	1	1.67	6	0.63	65,200		
Jun 30	123	841	964	14	11.38	72	8.56	65,700		

APPENDIX TABLE 2 - Continued

	Steelhead	Chinook	Daily Total	Collection Mortality Steelhead #'s	%	Chinook #'s	%	Daily Average River Flow in CFS	Spill Total	%
Jul 1	98	666	764	2	2.04	15	2.25	52,800		
Jul 2	49	749	798	8	16.33	19	2.54	49,900		
Jul 3	57	864	921	1	1.75	14	1.62	51,300		
Jul 4	195	972	1,167	12	6.15	54	5.56	43,700		
Jul 5	93	462	555	6	6.45	24	5.19	42,000		
Jul 6	45	946	991	6	13.33	32	3.38	45,900		
Jul 7	79	1,664	1,743	1	1.26	11	0.66	53,400		
Jul 8	153	1,545	1,698	4	2.61	25	1.62	54,900		
Jul 9	268	2,352	2,620	2	0.75	23	0.98	44,600		
Jul 10	82	1,276	1,358	2	2.44	41	3.21	42,100		
Jul 11	58	869	927	0	0.00	11	1.27	42,300		
Jul 12	58	972	1,030	5	8.62	33	3.39	26,700		
Jul 13	51	864	915	5	9.80	33	3.82	38,000		
Jul 14	65	831	896	12	18.46	65	7.82	39,600		
Jul 15	59	751	810	10	16.95	75	9.99	33,000		
Jul 16	58	742	800	18	31.03	133	17.92	32,700		
Jul 17	40	510	550	9	22.50	75	14.71	31,500		
Jul 18	43	221	264	6	13.95	45	20.36	43,100		
Jul 19	68	350	418	1	1.47	18	5.14	24,900		
Jul 20	22	518	540	/A	-	32	6.18	31,500		
Jul 21	29	687	716	1	3.45	15	2.18	33,100		
Jul 22	7	156	163	0	0.00	42	26.92	39,400		
Jul 23	9	136	145	1	11.11	7	5.15	29,200		
Jul 24	24	373	397	2	8.33	31	8.31	18,900		
TOTAL	899,739	590,449	1,490,188	6,784	0.7	7,759	1.3			

* April 10-20 combined species mortality = 356 or 22.02
/A Steelhead mortality (36) exceeded total steelhead collected

APPENDIX TABLE 3.--Daily collection counts of steelhead, spring chinook, fall chinook, coho, and sockeye, facility mortalities; and daily river flows and spills at McNary Dam, 1981.

	Daily Collection						Total Collection Mortality				
	Steelhead	Spring Chinook	Fall Chinook	Coho	Sockeye	Daily Total	#	%	River Flow in CFS	Spill Total	%
Mar 27	102	2,257		33	33	2,425	19	0.78	145,700		
Mar 28	162	3,432		53	53	3,700	2	0.05	142,900		
Mar 29	303	6,677		99	99	7,178	24	0.33	128,000		
Mar 30	273	5,903		89	89	6,354	56	0.88	145,800		
Mar 31		8,341				8,341	41	0.49	143,200		
Apr 1	31	7,740				7,771	43	0.55	163,100		
Apr 2	70	4,577				4,647	35	0.75	161,100		
Apr 3	184	3,820				4,004	29	0.72	141,700		
Apr 4	218	4,801				5,019	18	0.36	156,700		
Apr 5	205	3,941				4,146	22	0.53	123,700		
Apr 6	194	3,441			16	3,651	14	0.38	143,100		
Apr 7	137	1,627			14	1,778	25	1.41	150,900		
Apr 8	86	1,028			9	1,123	24	2.14	141,900		
Apr 9	68	2,117				2,185	16	0.73	158,500		
Apr 10	182	2,609			45	2,836	16	0.56	148,100		
Apr 11	426	2,852				3,278	18	0.55	140,800		
Apr 12	138	2,610			14	2,762	15	0.54	124,800		
Apr 13	342	3,624			16	3,982	22	0.55	153,900		
Apr 14	220	1,487				1,707	19	1.11	143,500		
Apr 15	158	1,795			44	1,997	5	0.25	132,600		
Apr 16	141	1,545			12	1,698	4	0.24	148,200		
Apr 17	279	1,584				1,863	3	0.16	128,700		
Apr 18	684	1,940			26	2,650	19	0.71	123,700		
Apr 19	387	1,778			22	2,187	20	0.91	109,000		
Apr 20	461	2,014			18	2,493	26	1.04	129,800		
Apr 21	574	2,563				3,137	15	0.48	158,300		
Apr 22	613	3,057				3,670	34	0.93	151,600		
Apr 23	1,309	4,652			42	6,003	28	0.47	153,300		
Apr 24	1,348	5,176			20	6,544	69	1.05	165,700		

APPENDIX TABLE 3 - Continued

	Steelhead	Daily Collection Spring Chinook	Fall Chinook	Coho	Sockeye	Daily Total	Total Collection Mortality #	%	River Flow in CFS	Spill Total	%
Apr 25	1,875	4,117			24	6,016	37	0.61	159,500		
Apr 26	2,255	5,501			47	7,803	109	1.40	142,000		
Apr 27	3,030	7,074			30	10,134	74	0.73	138,300		
Apr 28	4,005	9,296			94	13,395	134	1.00	170,000		
Apr 29	3,571	9,419			92	13,082	331	2.53	180,600		
Apr 30	4,615	22,993			195	27,803	240	0.86	205,800		
May 1	3,440	13,758				17,198	258	1.50	205,000		
May 2	4,141	19,224			165	23,530	204	0.87	257,000		
May 3	8,262	24,520			264	33,046	471	1.42	239,500	14,700	6
May 4	11,808	57,474		498	1,351	71,131	799	1.12	265,700	45,800	17
May 5	17,632	69,798		2,010	1,919	91,359	469	0.51	249,900	30,300	12
May 6	18,723	76,690		7,828	2,539	105,780	550	0.52	242,700	32,600	13
May 7	10,526	54,824		8,103	2,271	75,724	548	0.72	237,900	30,500	13
May 8	9,507	69,806		3,512	2,827	85,652	473	0.55	232,600	7,400	3
May 9	15,008	88,594		1,232	7,168	112,002	361	0.32	179,400	3,500	2
May 10	13,859	89,257		4,421	11,948	119,485	577	0.45	170,300	2,900	2
May 11	23,548	98,195		2,309	29,859	153,911	477	0.31	193,200	1,300	1
May 12	14,237	43,898		1,424	59,085	118,644	943	0.79	219,200		
May 13	19,801	56,455	4,213	1,475	23,383	105,327	403	0.38	206,800		
May 14	8,196	23,370	1,744	610	9,679	43,599	526	1.21	216.100		
May 15	9,955	25,673	3,144	1,048	12,575	52,395	505	0.96	226,600		
May 16	17,644	45,504	5,572	1,857	22,288	92,865	669	0.72	199,900		
May 17	8,413	38,287	530	1,788	17,223	66,241	337	0.51	178,000		
May 18	6,373	29,290	703	2,765	7,733	46,864	418	0.89	187,500		
May 19	4,187	14,189	639	2,966	36,169	58,150	725	1.25	197,800		
May 20	6,968	22,885	610	5,950	14,443	50,856	648	1.27	208,100		
May 21	5,459	19,083	399	7,145	12,295	44,381	516	1.16	229,600		
May 22	7,622	17,934	448	4,931	13,899	44,834	364	0.59	235,800		
May 23	9,291	15,300	606	10,604	14,659	50,460	400	0.79	244,200	14,700	6
May 24	9,920	9,141	205	6,436	15,290	40,992	429	1.05	220,200		

APPENDIX TABLE 3 - Continued

	Daily Collection Steelhead	Spring Chinook	Fall Chinook	Coho	Sockeye	Daily Total	Total Collection Mortality #	%	River Flow in CFS	Spill Total	%
May 25	8,110	7,881	1,290	4,958	6,420	28,659	382	1.33	220,700		
May 26	9,799	6,681	322	3,984	3,959	24,745	247	1.00	255,800	22,600	9
May 27	6,804	9,152		1,938	3,639	21,533	207	0.96	291,600	74,500	25
May 28	5,631	5,431	219	3,171	3,772	18,224	421	2.31	308,500	133,600	43
May 29	4,487	3,814	407	813	3,191	12,712	306	2.41	307,900	85,000	27
May 30	6,554	5,785	980	2,633	3,268	19,220	424	2.21	352,700	158,700	45
May 31	6,825	6,604	1,217	1,217	2,582	18,445	185	1.00	355,600	174,300	49
Jun 1	6,156	3,778	1,802	2,183	3,050	16,969	431	2,54	371,400	198,400	54
Jun 2	3,524	2,178	3,032	761	2,213	11,708	114	0.97	381,900	212,600	55
Jun 3	2,382	1,107	4,080	991	1,982	10,542	48	0.45	374,700	214,700	57
Jun 4	1,177	783	1,448	543	575	4,526	165	3.65	369,500	211,700	57
Jun 5	584	330	2,561	402	584	4,461	109	2.44	394,900	229,300	60
Jun 6	937	182	1,473	118	173	2,883	62	2.15	374,400	228,400	60
Jun 7	761	296	1,920	126	295	3,398	159	4.68	378,200	277,200	71
Jun 8	415	395	3,403	218	592	5,023	223	4.44	367,100	195,300	55
Jun 9	581	60	10,852	327	178	12,098	127	1.05	421,900	288,300	67
Jun 10	916	96	5,080	186	128	6,406	125	1.95	419,600	260,600	63
Jun 11	374	275	5,448	44	100	6,241	129	2.07	407,100	168,900	64
Jun 12	561	77	4,335	102	26	5,101	117	2.29	395,400	222,700	57
Jun 13	407		4,708	244	71	5,430	113	2.08	386,700	219,500	56
Jun 14	751	178	5,396	362	144	6,831	113	1.65	396,300	229,400	57
Jun 15	377	384	6,453	89	81	7,384	103	1.39	379,900	195,600	54
Jun 16	302	267	6,306	70	77	7,022	260	3.70	360,500	215,400	55
Jun 17	410	372	3,683	248	57	4,770	92	1.93	357,200	150,000	45
Jun 18	368	221	6,257	294	221	7,361	122	1.66	347,100	153,900	45
Jun 19	322	40	12,888	54	121	13,425	183	1.36	341,600	144,900	42
Jun 20	148	18	5,902	25	55	6,148	143	2.33	340,400	145,100	44
Jun 21	456	407	1,327	30	107	2,327	46	1.98	359,900	227,700	64
Jun 22	168	15	1,808	37	48	2,076	44	2.12	331,700	144,100	43
Jun 23	172	15	1,847	38	49	2,121	64	3,02	332,700	152,000	45
Jun 24	132	5	1,577	52	42	1,808	38	2.10	358,200	188,300	52

APPENDIX TABLE 3 - Continued

	Daily Collection						Total Collection Mortality			Spill	
	Steelhead	Spring Chinook	Fall Chinook	Coho	Sockeye	Daily Total	#	%	River Flow in CFS	Total	%
Jun 25	118	5	1,413	47	37	1,620	17	1.00	312,400	132,200	42
Jun 26	71	3	2,136	29	57	2,296	52	2.26	310,000	88,500	29
Jun 27	179		5,377	75	144	5,775	115	1.99	304,400	67,100	23
Jun 28	289	187	15,951	187	391	17,005	191	1.12	288,000	53,900	19
Jun 29	627		61,870	63	125	62,685	337	0.54	272,700	41,100	16
Jun 30	1,763		174,060	176	353	176,352	1,193	0.68	259,200	37,500	14
Jul 1	737		72,728	74	147	73,686	301	0.41	228,400		
Jul 2	976		96,329	98	195	97,598	647	0.66	226,100		
Jul 3	256		63,652			63,908	703	1.10	235,600		
Jul 4	185		46,191			46,376	306	0.66	226,200	1,400	1
Jul 5	63		15,581			15,644	212	1.36	227,600	5,400	2
Jul 6	28	96	13,572		69	13,765	178	1.29	243,500	8,200	3
Jul 7	20	71	10,030		51	10,172	230	2.26	276,200	42,900	16
Jul 8	15		7,477	15	45	7,552	99	1.31	308,700	80,600	26
Jul 9			15,738		240	15,978	320	2.00	294,900	63,700	22
Jul 10	22		31,130	12	122	31,286	557	1.78	277,200	52,600	19
Jul 11			59,955		241	60,196	448	0.74	240,100	6,200	3
Jul 12			63,023		253	63,276	672	1.06	209,800	5,500	2
Jul 13			39,301		238	39,539	359	0.91	230,000		
Jul 14			39,061		157	39,218	335	0.85	219,400		
Jul 15			71,437		359	71,796	460	0.64	221,600		
Jul 16			62,309		313	62,622	365	0.50	210,900		
Jul 17	7		34,191		206	34,404	399	1.16	226,400		
Jul 18			21,835		110	21,945	300	1.37	224,400		
Jul 19			17,755		143	17,898	316	1.77	210,800		
Jul 20			12,819		103	12,922	250	1.93	227,900		
Jul 21			11,521		352	11,873	312	2.63	214,200		
Jul 22			15,054		354	15,408	136	0.88	218,900		
Jul 23			32,173		757	32,930	835	2.54	219,200		

APPENDIX TABLE 3 - Continued

	Steelhead	Spring Chinook	Daily Collection Fall Chinook	Coho	Sockeye	Daily Total	Total Collection Mortality #	%	River Flow in CFS	Spill Total	%
Jul 24			34,508		104	34,612	707	2.04	205,900		
Jul 25			37,358		112	37,470	851	2.27	181,600		
Jul 26			58,891		177	59,068	640	1.08	167,100		
Jul 27			58,547		294	58,841	1,107	1.88	203,600		
Jul 28			73,085		368	73,453	1,824	2.48	183,700		
Jul 29			38,003		307	38,310	1,205	3.14	197,100		
Jul 30			21,284		150	21,434	392	1.83	203,200		
Jul 31			24,995		355	25,350	600	2.37	218,700		
Aug 1			39,453		970	40,423	705	1.74	207,000		
Aug 2			49,024		1,206	50,230	851	1.69	180,000		
Aug 3			44,655		134	44,789	1,377	3.07	179,100		
Aug 4			29,015			29,015	750	2.58	184,200		
Aug 5			25,286			25,286	795	3.14	198,600		
Aug 6			53,173			53,173	2,716	5.11	179,300		
Aug 7			52,490			52,490	1,100	2.10	195,800		
Aug 8			38,818			38,818	845	2.18	177,400		
Aug 9			25,615			25,615	629	2.46	151,300		
Aug 10			8,595			8,595	252	2.93	172,700		
Aug 11			2,724			2,724	434	1.59	176,600		
Aug 12			7,429			7,429	314	4.23	182,500		
Aug 13			3,105			3,105	298	9.59	171,800		
Aug 14			4,800			4,800	574	11.96	183,000		
Aug 15			10,984			10,984	913	8.31	175,200		
Aug 16			14,104			14,104	1,006	7.13	140,700		
Aug 17			9,267			9,267	599	6.46	162,100		
Aug 18			5,620			5,620	517	9.20	155,500		
Aug 19			8,502			8,502	548	6.35	149,400		
Aug 20			12,441			12,441	438	3.52	160,000		
Aug 21			5,574			5,574	424	7.61	140,800		
Aug 22			3,778			3,778	245	6.48	153,900		
Aug 23			2,558			2,558	280	10.95	132,600		

APPENDIX TABLE 3 - Continued

	Steelhead	Spring Chinook	Daily Collection Fall Chinook	Coho	Sockeye	Daily Total	Total Collection Mortality #	%	River Flow in CFS	Spill Total	%
Aug 24			1,916			1,916	221	11.53	119,200		
Aug 25			1,559			1,559	244	15.65	140,000		
Aug 26			2,732			2,732	260	9.52	151,000		
Aug 27			3,153			3,153	195	6.18	144,500		
Aug 28			5,419			5,419	320	5.91	143,900		
Aug 29			16,204			16,204	605	3.73	125,400		
Aug 30			14,406			14,406	615	4.27	114,100		
Aug 31			7,147			7,147	209	2.92	131,600		
Sep 1			4,667			4,667	333	7.14	138,800		
Sep 2			2,167			2,167	187	8.63	129,600		
Sep 3			3,590			3,590	169	4.71	126,800		
Sep 4			3,209			3,209	156	4.86	132,500		
Sep 5			2,752			2,752	209	7.59	99,800		
Sep 6			2,542			2,542	233	9.17	76,400		
Sep 7			1,348			1,348	106	7.86	65,000		
Sep 8			806			806	122	15.14	117,800		
Sep 9			1,114			1,114	87	7.81	120,700		
Sep 10			1,823			1,823	121	6.64	114,000		
Sep 11			984			984	139	14.13	125,200		
TOTAL	366,419	1,237,726	2,121,722	106,220	367,725	4,202,506	58,090				

APPENDIX TABLE 4.--Summary of fish marked at Lower Granite and McNary Dams in 1981.

	Spring chinook	Fall chinook	Steelhead	Sockeye	Coho	Mark
<u>LOWER GRANITE DAM</u>						
<u>Transport Evaluation</u>						
Bonneville (Barge)	20,363					Ad, Brand & CWT
<u>Indexing Study (NWAFC)</u>						
Forebay (Lower Granite)	15,857		39,841			Brand only
Little Goose Tailrace	5,346		6,096			Brand only
<u>MCNARY DAM</u>						
<u>Transport Evaluation</u> (July Release)						
Bonneville (Truck)		42,924				Ad, Brand & CWT
McNary Tailrace		42,580				Ad, Brand & CWT
<u>John Day Dam Evaluation</u>						
McNary Tailrace (Spring release)	19,491		15,223	5,156	1,415	Brand only
McNary Tailrace (June release)		17,723				Ad, Brand & CWT
McNary Tailrace (August release)		16,779				Ad, Brand & CWT